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STATISTICAL METHODS.

It is, according to the journalists, a traditional belief of the man in the street, that statistics will prove anything. The agriculturist, concerned with interpreting the results of his researches or his field trials, is under no such illusion. He often suffers the disappointment of finding that differences that he is convinced are real, will not pass the common statistical tests. Like his fellow workers in other branches of biological science he has to deal with material that is extremely variable; and though he can often give a plausible explanation of variation in particular individuals or plots of land, he must as a rule seek for generalisations which over-ride the individual case. In testing those generalisations statistical methods are essential.

It is true that no amount of statistical calculation can quite take the place of the original data. But, on the other hand, data collected without reference to the principles which must govern any statistical analysis, may not only be useless, but actually misleading. For instance, the statistical theory of field trials states not only the method to be used in handling the data, but also the conditions to be observed in planning the experiment. If, through faulty planning, the estimate of error is inaccurate, it will usually be found that the mean yields obtained for the treatments or varieties compared are biased also. This is an important point since it is difficult to avoid being influenced by the mean yields, even when the results are statistically inconclusive.

In the increasing development of tropical countries and the parallel expansion of agricultural research, experimental trials of varieties and of cultural methods are bound to play a large part. It is the final test both of long range and of *ad hoc* research. Careful application of the appropriate statistical methods should make progress both more rapid and more sure. To this, as to any other application of mathematics to the experimental sciences, the saying, attributed to Huxley, applies—that mathematics is like a mill, which turns out only what is put into it. A variety of practical considerations, and often, perhaps, a flair for what is likely to prove important, rather than a carefully built up chain of evidence, will determine the questions which it is decided to test. But, once the questions are chosen, the way in which they are tested, from the first lay-out of the experiment to the analysis of results, must follow certain definite statistical rules. Moreover, the discipline of conducting

an accurate test of agricultural or any other scientific questions makes always for greater clarity in defining both the questions themselves and the potentialities of the results.

It is possible that at times too much attention, or rather too concentrated an attention, has been expended on the experimental error of plot trials. Pre occupation with the problem of *reducing* the experimental error due to field variation, has often involved losing sight, not only of the general principles which must govern statistical methods, but also of the important question, how widely the results obtained can be applied. Many methods involving the sub-division of plots at harvest time purport to give an accuracy which, even if it were true, would be out of all proportion to the value of the results as a guide to agricultural practice or to subsequent experimental work. Not only so, but through neglect of general statistical principles, the apparent gain in accuracy in these cases is purely illusory.

F. L. Engledow and G. U. Yule in a recent and very useful account of the Principles and Practice of Yield Trials, published by the Empire Cotton Growing Corporation, have drawn attention to the limited value of the ordinary standard error as a guide to choice of varieties. They point out that no variety should be given an extended trial unless there is sure evidence of superiority and "reiterate the warning that yield trials should be accorded no credence nor even be divulged, unless accompanied by evidence of statistical significance." But they point out also that, in addition to the standard error due to ground conditions, on which attention has been almost exclusively concentrated in the past, there is a standard error due to weather fluctuations. The effective standard error of comparison, even for one type of soil, will be determined by a combination of both these sources of error. There will, further, be standard errors due to variation of soil type, and of local climate over the agricultural area to which it is desired to apply the results. These sources of variation have been realised in the past but have not been clearly related to the problem of experimental error.

The presence during recent years of mathematicians working in close association with biological departments (as at Rothamsted and Cambridge) has led to the development of statistical methods which take into consideration the type of variation the biologist has to meet, and the type of experiment he is able to carry out. The general method of analysis now applied to field trials, known as the analysis of variance, is admirably adapted for determining just what errors are likely to arise from each of the causes of variation noted. Field errors within a small area, such as would be used for one experimental set, are placed in their right perspective with reference to the variation due to soil type or weather. Experiments can be planned to cover a wide or a narrow range of experience without essential loss of accuracy in either case. In the earlier stages of variety testing, and in work directed towards the answering of physiological questions, experiments will normally cover only a narrow range of variation of soil and local climate. Field trials in the later stages will cover a wider range. Such trials, of which the co-operative field trials carried out under the direction of local agricultural departments are an example, have often fallen between the two stools of accurate results for each particular place, and general results valid for the whole range. With the more recent methods of planning experiments and analysing the data this dilemma need not arise.

The use of new tools always introduces some difficulties at first; it should however, lead not only to more accurate results, but to more efficient thinking in seeking and in applying the results. To attempt a general standardisation of methods at the moment would probably be more confusing than helpful. Although the general principles are clear, there is room for advance in methods of applying the principles to particular cases. And it must always be left to the individual investigator to decide how far he will push the analysis. He may wish his generalisation to be true over against a wide background of variation in soil and weather, which he will call his experimental error, or he may wish for more precise comparisons, with an experimental error due only to variations between closely adjacent plots. But once that decision is made the experiment must conform to certain statistical conditions if any confidence is to be placed in the results.

Although, as we note above, any attempt now at a general standardisation of methods would be inadvisable, the case for a wider use and understanding of the newer methods is very strong. Agricultural officers in training, or taking refresher courses should at least learn the principles of planning and analysing the results of experiments along the lines we have discussed. Equally important is the question of providing expert advice and guidance on statistical questions to officers actually engaged in experimental work. In an unofficial way something is already done, for example, by the Statistical Department at Rothamsted, which is always ready to give critical advice on schemes of experiments and on the analysis of results. This help, however, can only possibly be available for a very small fraction of the cases in which assistance of that kind would be invaluable. The question arises therefore, whether a complete scheme for research and training in tropical agriculture should not include a small central department responsible for this critical advice and training in statistical method. Such a department might also carry out valuable co-ordination work on the results from different tropical countries and lay the foundations of a better understanding of the influence of climate.

THE EDITOR is prepared to consider signed articles for publication in *Tropical Agriculture*. Such articles should normally vary between 1,000 to 6,000 words and may be illustrated if desired. Rates can be obtained on application to the Editor.

TRINIDAD COTTON RESEARCH STATION.

Genetics Department.

BY S. C. HARLAND, D.SC. (Lond.), *Geneticist.*

THE Cotton Research Station in Trinidad was initiated by the Empire Cotton Growing Corporation in order to study the genetics and physiology of the cotton plant. It is probably a unique institution in that economic results are made subservient to purely scientific investigations. Scientific studies of the cotton plant which have so far been made have usually been out-growths of agricultural problems, but much good work has been accomplished, particularly by such workers as Balls in Egypt, Leake in India and Kearney in America. The idea, however, of concentrating the work of a Research Station—subsidised, be it remembered, by the Cotton manufacturers— on studies which at first sight appear to have little bearing on cotton growing problems is a strange one to the practical man, but in reality it speaks volumes for the foresight of those who established the Station. For, as work continues, it becomes increasingly obvious that it is only by an exhaustive study of the genetics of cotton that cotton-breeding may presently emerge as a real science, from its present status as an empiric art. The reasons for this belief will be more fully discussed in a later section.

The Cotton Station has at present only two Departments, Genetics and Physiology. There is a Head for each Department, and an Assistant. On the genetics side there is a Field Assistant who is also responsible for the cytological work, a Librarian, an Artist, and four other assistants who are engaged in the examination of genetic material from the field, and in working up the results. The Genetics Laboratory is a bungalow of five rooms together with a photographic darkroom and a large store-room. There are two greenhouses which are roofed with glass and the sides of which are enclosed with mosquito gauze. The area of land at present under genetic experiments is about 15 acres. Work was commenced in June, 1926 and our first step was to collect a representative series of cottons from all over the world to form the basis for crossing experiments. At the present time we have probably the most complete collection of cotton types in the world. The genetic investigations are divided into three main divisions:—

(*a*) New World Cottons including Upland, Sea Island, Egyptian, Peruvian and Brazilian cottons together with other related types from Africa and New Guinea and the Tree Cottons from Central America.

(*b*) Asiatic cottons consisting of cottons from China, Burma, India, Sudan, Transvaal and Turkestan.

(*c*) Purely wild species such as *Gossypium tomentosum* from Hawaii, *G. Stocksii* from India, *G. davidsonii* from Mexico and *G. sturtii* from Australia.

The study of hybrids between wild and cultivated species is also being carried on.

From a purely scientific point of view one of the main points of interest is that in the genus *Gossypium* there are two types of chromosome number, viz.: 13 pairs in Asiatics and also in *G. davidsonii* and *G. stocksii*, and 26 pairs in the New World Cottons, and also in *G. tomentosum*. *G. sturtii* may possibly form a section by itself with some number higher than 26. Variation in Asiatic and in New World Cottons runs along parallel lines. Thus in both groups there are both hairy and smooth forms, various grades of leaf shape, of petal colour, and of habit, &c. It is hoped that it will be possible to make a separate chromosome map for each of the main divisions of the genus, and it is clear that we may be able, by comparing the maps, to learn something not only about the mechanism of evolution in the genus, but possibly also to throw light upon the evolution question in general. So far we have obtained one case in which one of the chromosomes of the Asiatic group may have its representative in the New World group. The genes for red leaf, petal spot and node number are linked in New World Cottons. The genes for red and a node number gene are also linked in Asiatic cotton though in the latter the genes for red and petal spot appear to occupy the same locus in the chromosome.

Inheritance in New World Cottons appears to be far more complex than in the Asiatic group, for in the former group it is often the rule to find in the second generation of a cross, involving a particular pair of characters, a series of intermediates which proceed by imperceptible gradations from one parental extreme to the other and may transcend the parental limits in either or both directions. The same character in Asiatics may show simple and clear cut segregation with no intermediates. Thus, to analyse the inheritance of petal spot in a cross of Upland x Sea Island, we were obliged to make 22 different grades, ranging from a full spot of Sea Island to the spotless condition of Upland. Inheritance of this character proved to be extraordinarily complicated and was due to a series of multiple allelomorphs giving rise to spot grades of different intensities, and in addition, each grade was capable of great distortion through the action of an unknown number of modifying factors. The inheritance of petal spot in Asiatic cottons follows the ordinary Mendelian law with full spot dominant in F^1 and clear cut segregation into spotted and spotless in F^2. It seems clear that the more complicated type of inheritance in New World Cottons is in some way a consequence of the higher chromosome number though we are not at present able to say why.

In each group attention is at present being devoted mainly to the discovery of genes which show clear cut segregation and which are capable of being used for the construction of a chromosome map. Examples of such genes in the New World group are the following pairs :—

Tufted and naked seed, fuzzy and tufted seed, dominant naked and woolly seed, red and green leaves, yellow and white flower, green and chlorophyll deficiency, &c. When a number of genes are known in some or all of the chromosomes it will then be possible to study the mode of inheritance of economic characters, such as lint length and quality, boll size, resistance to disease, &c.—not directly, but by making use of their linkage relations with known genes. For example we already know that one of the main genes determining whether the cotton is annual or perennial, that is, whether the cotton possesses a high or a low node number is linked with the factor for red anthyocyanin pigmentation of the leaf and stem. It is further clear that unless we were aware of this linkage we should never be able to elucidate the mode of inheritance of such a complicated character as this. Another complicated character of commercial importance which is beginning to yield to analysis is the mean number of loculi in the boll which has one of its genes linked to the gene for yellow pollen. Lint length is also in some way connected with flower colour.

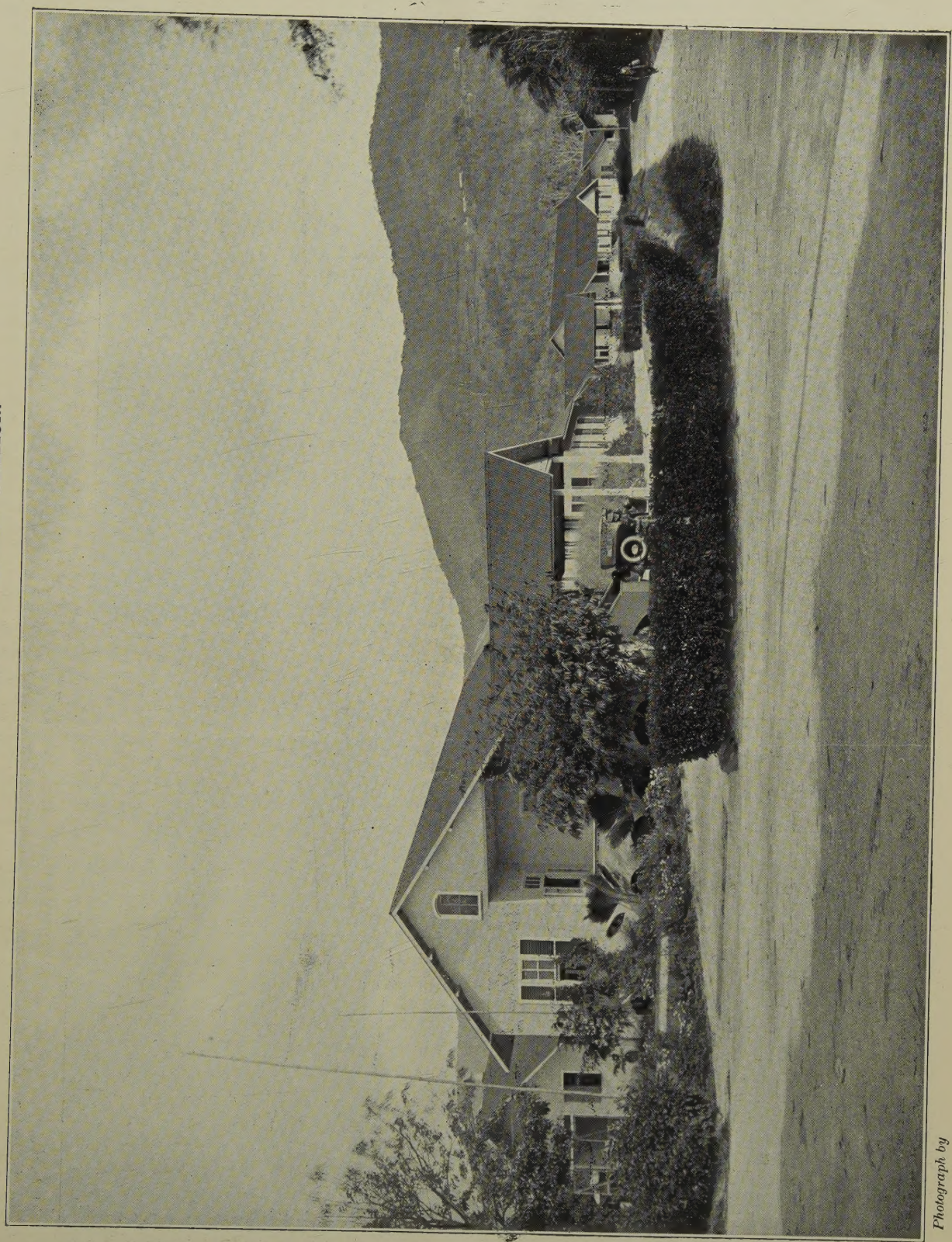
The genetic investigations are producing some useful bye-products which may be of great commercial value. Recently hybrids have been made for the first time between the wild Hawaiian species *G. tomentosum* and American Upland cotton. *G. tomentosum* is characterised by extreme drought resistance and is covered by a thick felt of hairs which enables it to resist the attacks of leaf sucking insects. Its seeds have no lint at all but only a short khaki fuzz, the hybrid with Sea Island however produces a beautiful khaki lint of Egyptian quality. It is also under our conditions completely immune to angular leaf spot (black-arm). There is every prospect of being able to combine these valuable characters with the commercial character of Upland, Egyptian or Sea Island cotton. The potential benefits arising from investigations of this kind are enormous. A word may here be said about the possible results of inter-specific hybridisation. It has always been the opinion of practical cotton breeders that it is quite impossible to combine the desirable characters of Upland cotton with those of Egyptian. Our genetic studies of the last two years lead us to believe that inter-specific hybridisation is the most promising line of attack in the improvement of existing types of cotton. There appears to be no reason whatever why the long lint of Sea Island cotton should not be transferred to an Upland plant body.

Asiatic cottons also appear capable of a similar improvement and an Asiatic cotton with a mean maximum lint length of 30 mm. and of good agricultural qualities is already within sight.

In such a climate as that of Trinidad the difficulties of carrying on genetic investigations with cotton are very great, but these are gradually being overcome. Much of our most valuable genetic material is of very weak constitution and consists of such types as male sterile forms, chlorophyll deficiencies, crinkled dwarfs, &c. Such plants require much more than ordinary agricultural treatment, and we have found it necessary to sow all seeds in pots, afterwards transplanting to the field so as to ensure a perfect stand, and to avoid elimination in the seedling stage by the more rigorous conditions which sowing in the field would provide. Thus if we planted an F^2 segregating into chlorophyll deficiency and crinkled dwarf directly into the field, these types would be almost entirely eliminated in the seedling stage and great distortion of Mendelian ratios in respect of other genes would occur. Treatment of our plants is thus essentially horticultural and not agricultural. A single genetic experiment may last from 4-5 years, for the full genetic possibilities of a cross cannot be decided in a single season. After every season therefore, there remains in every field a large number of plants which it is desirable to make further use of either as standards for some character, to obtain larger families the following season, or to use for further crossing experiments. A single plant of a dilute Upland-Egyptian hybrid has been continuously worked with since 1924 and has been grafted and regrafted on a large scale in every subsequent year. We have also found it essential to preserve an extensive series of standard types of cotton possessing certain genic combinations for use in analysing the results of other crosses on a comparative basis. Our fields are thus occupied at one and the same period by standard types, parents, F^1s, F^2s, backcrosses, &c. any of which may be removed during the growing season to make way for types which offer greater interest.

Genetically speaking our main aim is to sift all recessives into one type and all dominants into another, so that by back-crossing a large series of heterozygous dominants with a multiple recessive we shall be able exactly to understand the mode of inter-action of various genic combinations. The greenhouses are an essential adjunct to the work; without them we should find it impossible to preserve many of our standard types alive through the dry season and particularly through the two months during which the plants are heavily cut back in order to provide a close season against the cotton stainer and the pink boll worm. It has been found that hybridisation work can only be done without risk of interference by foreign pollen in the greenhouses, as cases of ants transferring pollen are not infrequent under field conditions. Both greenhouses have now been made ant proof by means of a box drain filled with water completely surrounding the buildings. For the propagation of single plants from which it is desired to obtain large families, grafting

TRINIDAD COTTON RESEARCH STATION.



Staff houses and laboratories.

Photograph by Tucker Picture Co.

TRINIDAD COTTON RESEARCH STATION.

Photograph by *Tucker Picture Co.*

One of the laboratories.

Photograph by *Tucker Picture Co.*

Field Office.

and budding are extensively employed, and we often set ourselves the task of increasing a single plant to the number of 50 or more by grafting on a hardy tree cotton.

A method has been devised for growing cotton from cuttings in which use is made of a solar propagator, which has been invented by workers in the United States. It consists essentially of a glass frame which acts as a sun trap. The hot air passes underneath a bed of sand about six inches thick, which is also roofed with glass. For the greater part of the day the sand warmed by the hot air underneath is at a higher temperature than that of the air and provides ideal conditions for rooting of soft cuttings from 2½ to 3½ inches long. This method will be employed in the future for the propagation of pure lines on a large scale. Cuttings are of course easily rooted in greenhouses in a temperate climate, but until the employment of the solar propagator, the difficulties of growing cotton from cuttings in the tropics had not been fully overcome.

It is our custom to number every plant in the genetic plots by means of stamped aluminium labels. At first we employed the numbered leg bands used by poultry fanciers, but we now have an Embossing Press manufactured by the British Automatic Company. Efficient numbering of the plants is essential in genetic experiments. When the writer was in St. Vincent he made extensive use of small squares of sheet lead on which the plant numbers were stamped. A large number of these disappeared one night, and it was subsequently discovered that they were being used as sinkers by the local fishermen.

The examination of flower and seed characters is all done in the Laboratory. Flowers are collected early in the morning by trained boys who use boxes containing 48 compartments, each large enough to take one or two flowers. A slip of paper with the number of the family and of the plant is put into each compartment by the collector.

Selfing of the flowers is done by trying a small piece of string round the end of the bud on the afternoon before it opens. On the afternoon of the next day a further piece of string is tied round the stem of all flowers which are properly selfed. It is not advisable to tie the flower stem at the same time as the bud is tied because the string is occasionally forced off by the expansion of the bud. Other methods of selfing have been tried such as placing a coil of copper or lead wire round the bud, or sewing up the end of the bud with a needle, but none of these methods have proved as satisfactory as the one we employ.

A modification has also been made in the existing method of crossing. The usual method is to cut away the corolla completely, but better results are obtained if only a small incision is made at the base of the bud and one petal only removed. The other petals can then be folded back, the stamens removed and the petals refolded over the stigma. If the operation is done properly the young boll will practically never drop. Pollination is usually done the following morning but pollen a day old can be used at the time the flower is emasculated, provided it has previously been kept in a desiccator. It is hoped that these short notes on methods may be of assistance to cotton workers in other parts of the world, and the writer would welcome the opportunity of describing any of his methods in greater detail.

The results of the investigations are to be published first in the standard genetic journals, and will afterwards be issued as separate memoirs of the Cotton Research Station.

BRAZIL COFFEE.

LATE advices from Brazil, indicate that the crops in many parts of Sao Paulo, the principal producing district, are being visited by the dreaded pest, *Stephanoderes*, which, coupled with an absence of rain, threatens a considerable proportion of the trees. When it is remembered that cultivation of the bean represents the chief source of the country's income from exports, say, about 75 per cent., the threatened trouble assumes some significance. This is frankly recognised by the Agricultural League, which, in a recent report, admits that nearly 20 per cent. of the trees have already been affected, and that there is danger of the disease spreading to other—and even to far-distant districts. Some estates seem to have been more unfortunate than others; for (again quoting the League's report) as much as 95 per cent. of certain plantations have been attacked. An infected plantation may, however, be cleansed, and the disease, if dealt with in its early stages, destroyed. The surest means is to spray or powder the plants with a mixture of lime and sulphur, as is done in Ceylon in the case of the local pest known as *Hemileia vastatrix*, or coffee-leaf disease. Unfortunately, it seems that, fortified by the present prosperity of the coffee industry, Brazilian estate-proprietors are inclined to let things slide. If one may credit some of its prominent critics, the Coffee Institute, or, to give it its full title, "The Institute of Permanent Defence of Coffee of Sao Paulo," now nearly four years in existence (whose objectives include the withdrawal of coffee from the local market by purchase and storing it in warehouses specially set aside for that purpose) has not concerned itself as wholeheartedly as it might have done with the pest question. It has now under supervision no fewer than 1,000,000,000 trees, against 850,000,000 in 1925, distributed over nearly 1,300,000,000 hectares (1 hectare=2.47 acres). Unless measures are taken to combat the present visitations it seems hardly likely that the Brazilian harvest in 1929-30 will reach 18,000,000 bags (or 50 per cent. above this season's production), as fore-shadowed; but as this year's production is estimated to fill 12,000,000 bags, against a world consumption of 24,000,000 and although the shadow of the pest calamity may loom against future production, the present statistical position of Brazilian coffee is favourable enough.—(*The Economist*, Vol. CVII, No. 4434.)

EXPERIMENTAL ERROR.

A Survey of Recent Advances in Statistical Method.

By E. J. MASKELL, M.A., Ph.D. (Cantab.),
Assistant Physiologist, Cotton Research Station; Trinidad.

It has been fully recognised for many years now, that the data obtained from field trials must be subjected to certain statistical tests before valid conclusions can be drawn. Consequently most of the accounts of field trials published at the present time contain either a statement of the experimental error, or an apology for its absence. Of recent years it has come to be realised that the mere application of certain calculations to the data obtained is not sufficient. The way in which the experiment is planned must equally satisfy certain statistical conditions if any valid conclusions are to be possible. Thanks to recent advances in statistical method, notably by R. A. Fisher and "Student," these conditions can be very simply stated, and at the same time the statistical analysis of the data obtained is considerably simplified. Not only do the newer methods enable one to calculate a valid estimate of error but also, by emphasising the importance of the plan of the experiment, they should make for greater precision in defining the questions that the experiment is intended to test. In addition they indicate how, without loss of accuracy, the scope of an experiment may be extended to cover a wider range of experience than has usually been attempted.

In view of the importance of the subject, and of the fact that the newer methods are not yet generally known, it was felt that a survey of the principles involved and of the methods of calculation employed, might be of use to students of tropical agriculture. This paper was written with that end in view, and it is hoped that it may at least serve as an introduction to the original literature.

Broadly speaking, experimental work in agricultural science is of two types, (1) measurement of the effect on yield of a definite change in the environment (manurial and cultural experiments) or in the plant (comparison of new varieties), (2) observation and analysis of the environmental factors affecting yield. In the first case we have the problem of variations in yield between different patches of similarly treated land; in the second case, where we observe and then attempt to establish correlations, we have the problem of the residual variation which we cannot explain. In both cases we need to know how often the results we observe could arise merely by chance combinations of the uncontrolled or the unknown factors. It is one purpose of statistical analysis to answer that question.

The principles involved will be illustrated in the first place by considering the problem of experimental error in field trials. Experience of a large number of uniformity trials shows that, when land uniformly treated and sown to one variety is subdivided into many small plots, the yields of the plots approximate very closely to a distribution known as the normal curve of error. Relatively small deviations from the mean yield are common, relatively large deviations are rare. Now the form of the normal curve of error is defined by a statistic, the standard deviation, s, which can be calculated from the observed deviations. Knowing the standard deviation we can say how often a deviation of any particular size is likely to occur in a choice made at random. Thus a deviation greater than $2s$ *i.e.*, twice the standard deviation, would occur less than five times in one hundred trials.

Although the standard deviation must be used when testing the significance of any observed deviation, it is more convenient for many of the operations to work with the square of the standard deviation or *variance* (R. A. Fisher). The variance is defined statistically as the mean square deviation; thus $V = s^2 = Sum\ d^2 \div N$, where V = variance, s = standard deviation, d = any deviation from the mean, N = the total number of observations. The variance so calculated is the variance of a single observation. The variance of the sum of n observations, taken at random, is $n \times V$ and the variance of the mean of n such observations is $V \div n$. The variance of the sum or difference between two observations, or two means, is the sum of the variances of each, provided that there is no correlation between the pairs of observations. Since we have, in most experimental cases, to compare means of a number of observations, the advantages of working with the variance are obvious. It may be noted also that the variance is a useful measure of the accuracy of the experiment; for if in one experiment the variance is x and in another $4x$, then, in order to obtain in the second experiment the same accuracy as in the first, we should need four times as many observations, *i.e.*: four times as much land.

In order to apply the theory of errors to a field experiment, we must be able to estimate the variance due to differences between similarly treated plots. This is one of the objects of replication. In practice the number of replications is limited, so that only a small number of observations are available for calculating the statistics, instead of the very large number contemplated by the classical theory of errors This involves two modifications in method. In the first place a standard deviation calculated from a small number of cases is not very accurate; fortunately the extent to which standard deviations so calculated are likely to differ from the true standard deviation is known, and special tables, for testing the significance of observed deviations are now available for the case of small samples.[1,2] Since, however, the estimate of the standard deviation can, following the newer methods, be based on the *whole* of the data in an experiment, instead of on the small number of replicates for each treatment, the effective number of observations will not in general be very small.

The second modification in method concerns the use, customary for small samples, of $(n-1)$ instead of n, when dividing the sum of squares of the deviations to obtain the variance. The reasons for this procedure will be considered in some detail, since they form an introduction to two conceptions, namely *Analysis of Variance* and *Degrees of Freedom*, which are fundamental to the newer methods of analysis. The example taken is, of course, purely for the purpose of illustration.

Suppose we have 20 plots with the following yields: 8, 7, 7, 6, 6, 6, 6, 5, 5, 5, 5, 5, 5, 4, 4, 4, 4, 3, 3, 2. The distribution is approximately normal and the statistics are: *Mean*=5, *Sum* d^2=42, *Variance* = 42 ÷ 20 = 2.10. For the moment we are dividing by n (=20) instead of $n-1$. Now divide the 20 plots into 5 random groups of 4 plots each and calculate the variance separately for each sample, using for each sample its own mean.

Sample.	*Mean.*	*Sum* d^2	*Variance* $\left(\frac{Sum\ d^2}{4}\right)$	*Deviation of mean.*
A 5, 6, 8, 3	5.50	13.00	3.25	+ .5
B 5, 4, 4, 2	3.75	4.75	1.1875	− 1.25
C 5, 6, 6, 3	5.00	6.00	1.50	+ 0.0
D 6, 5, 4, 7	5.5	5.00	1.25	+ 0.5
E 5, 5, 4, 7	5.25	4.75	1.1875	+ 0.25
Total		33.5	$1.675 = \frac{33.5}{20}$	

Note that (1) the five samples give quite different variances, and the variance for any sample bears no relation to the deviation of the sample mean from the general mean; (2) the average variance 1.675 is considerably smaller than the value 2.1 which we know to be the true variance. This is due to the fact that the total sum of squares obtained is 33.5 as against the true value 42.0. If we now square the deviations of the sample means from the general mean (last column), sum the squares and multiply the sum by 4, since there are four plots in each sample, we have the figure 8.5 (4 × 2.125) which is exactly the difference between 42 and 33.5.

Thus the variance based on the five samples of four is too low, because we have taken no account of the variation of the sample means from the true mean. This bias is exactly eliminated if we take as our divisor for each sample not n but $n-1$, the 1 representing the mean which has been calculated from the sample itself. The divisor for the figure 33.5 is then not 20 but 15 (5 × 3) and the average variance is 2.233, much closer to the variance calculated for the whole population. In general we must subtract from the total number of observations the number of constants, derived from the observations themselves, which have been used in calculating the deviations. The number so obtained is termed (R. A. Fisher) the number of *Degrees of Freedom* in which variation is possible. For if with n observations the mean is fixed, then only $(n-1)$ of the observations can have any arbitrary value. In the case given above we took 20 plots and calculated a mean: hence the correct number of degrees of freedom is 19. We subdivided the plots into five samples of four. This gives us five sample means so that we have 4 (=5−1) degrees of freedom for the variation between the sample means. The 15 (5×(4−1)) remaining, represent the variation between plots in the same sample. The whole analysis may be set out as under.

	Degrees of freedom.	*Sum of squares.*	*Variance.*
Total	19	42	2.212
Between samples	4	8.5	2.125
Within samples ..	15	33.5	2.233

It will be noted the total variation (=total sum of squares) is divided into two parts (1) variation between samples (2) variation within samples. This method of dividing the total variation between the various factors which contribute to it, is the basis of the modern analysis of experimental results.

R. A. Fisher, to whom the method is due, has termed it the Analysis of Variance. A full account of the method and its applications will be found in his book. ([1])

In the case considered above the variance between samples is almost exactly the same as that within samples, and we should conclude that there is no real difference between the samples. This is to be expected since the groups were made up by random choice. In experimental trials, the samples, or groups, will represent different treatments or varieties, and we shall as a rule find that the variation between groups is greater than that within groups. If the difference is sufficiently great we shall conclude that there is a real effect of variety or treatment. Methods of testing the significance of any observed difference in variance are given by Fisher (*loc. cit.*). These enable one to answer for any experiment the general question, has there been any effect of treatment or variety? To test the significance of the difference between any particular pair of treatments however, the standard deviation, based on the variance within groups would be used.

The general form of the Analysis of Variance is given below, for n groups each having p members, *i.e.*: $n\,p$ observations in all.*

	Degrees of freedom.	Sum of squares.
Total ..	$np-1$	Sum $(y - Y)^2$
Between groups ..	$n-1$	$p \times$ Sum $(y_n - Y)^2$
Within groups ..	$n(p-1)$	Sum $(y - y_n)^2$

The variances are obtained by dividing the sum of squares by the appropriate number of degrees of freedom. The standard error, due to sampling, of a group mean is obtained by dividing the variance within groups by p (=No. of observations in a group) and taking the square root. To obtain the standard error of a difference between group means, this variance must first be multiplied by two. The sum of squares within groups can

* *Note*:—y=any observation, Y=mean of all observations, y_n=mean for any group.

be calculated by difference as: $Sum\ (y-Y)^2 - p \times Sum\ (y_n - Y)^2$ but to avoid arithmetical errors it is better to calculate it directly as $Sum\ (y-y_n)^2$. The total variation need not be calculated directly but may be obtained, if required, by summation.

The chief difference between this method of analysis and earlier methods lies in *the use of all the data to obtain a general estimate of the standard error* based on a larger number of degrees of freedom. It may be objected that the variation between replicates will not necessarily be the same for different treatments or varieties and that pooling of the data is not legitimate. If differential variation is suspected in any case the question may readily be tested by the method of comparing variances referred to earlier. In other cases some simple modification may meet the facts. For example, in experimental work involving large differences in yield, or in work involving comparison of plants at different stages of growth, it may be found that the variance is roughly proportional to the square of the mean, or to the mean. These cases may be met by carrying out the analysis, in the first case on the logarithms and in the second case on the square roots of the actual observations. In most cases of field trials, however, it is found that the field errors are distributed independently of variety or treatment.

So far we have tacitly assumed that the plots comprising each group are distributed at random over the experimental area. This is of fundamental importance, for uniformity trials have conclusively shewn that the distribution of yield variations in space is by no means random. Yield variation in the field is *heterogeneous, i.e.*: adjacent plots of land tend to have similar yields. Consequently, if groups are selected by taking in each case a block of adjacent plots, then (1) the variation between groups will be greater than that expected from the law of errors; (2) the variation within groups, on which the standard error is based, will be correspondingly too low. In such cases no test of the significance of a difference between varieties is possible. Large plots, sub-divided in this way into sub-plots, but not otherwise repeated, are no longer used; but schemes which secure an apparent increase in the number of replicates by the mere sub-division of plots at harvest time are not uncommon and are equally objectionable. Standard deviations so calculated may be totally misleading.

The simplest method of securing an unbiased estimate of the yields of the different varieties, and a valid estimate of the standard error, is to arrange the varieties completely at random. It can readily be shewn (Fisher *loc. cit.*) that this method is a satisfactory solution of the problem of field heterogeneity. Further, by introducing certain modifications, while at the same time retaining the principle of random arrangement, field heterogeneity may be not only overcome, but exploited. Suppose we are comparing p varieties each repeated n times. The whole experimental area is divided into n blocks each containing p plots. Each block is made to contain one plot of each variety and *within each block the varieties are arranged completely at random.* We noted above that field variation between plots in the same block of land is relatively small, while variation between different blocks or groups of plots is relatively big. Thus the standard error of comparison of the varieties will depend only on the relatively small field differences between closely adjacent plots, the relatively large differences between different regions of the field being eliminated from the comparison by making each variety occur once in each block. The field differences between closely adjacent plots are, moreover, distributed at random among the varieties, so that the normal law of errors can be applied. This method of *controlled random arrangement* is the general solution of the problem of plot technique. Analysis of the results is carried out by a simple extension of the analysis of variance already described. An example of the actual working will be given in the next paper of this series.

This method of plot arrangement and of analysing the results is recent. In the past other methods have been used, most of them open to serious objection. Historical surveys of these methods will be found in a number of recent publications and only brief reference will be made here. A common method has been to introduce '*control plots*' *e.g.*: standard varieties, at frequent intervals among the varieties being tested. This is often a waste of land which might have been used to secure greater accuracy in measuring the yield of the varieties which are being compared. The method is apt, moreover, to involve complicated calculations and corrections of observed yields.

For the comparison of only two varieties at a time *Beaven's half-strip method*, (4) in which the varieties are arranged A B B A A B B A, &c., has many advantages. This is really the limiting case of the general method of subdivision into blocks outlined above. Each pair of plots A B, or B A, forms a block; only for convenience in the sowing operations, the arrangement of A and B within the blocks alternates regularly, *i.e.*, A B then B A, instead of being determined by random choice. The chief interest of this case is that the standard error, which as we noted above, is based on differences between plots in the same block, is very simply calculated from the series of differences of A−B for each pair. (Alternatively and with somewhat greater accuracy A B B A may be regarded as a block; (A− −A) and (−B B−) as the two plots) (3).

The simplicity of this method of calculation, "Student's method," and the great reduction in the standard error usually obtained, has led to the extension of the A B B A arrangement to the

comparison of more than two varieties. For example, four varieties A B C D have been arranged in three pairs A B, A C, A D, and each pair has been compared on a different part of the experimental area by "Student's method." This, however, does not permit of any valid direct comparison between B, C and D and the method is much less accurate than the general method outlined above, in which A B C and D would occur, arranged at random, in each block of four plots.

The usual method for several varieties has been the 'chessboard,' in which a repeating pattern is followed: for example A B C D E

F G A B C

D E F G A, &c.

An objection is the regular order of the varieties, which is quite likely to produce a bias in the mean yields. The question of regular arrangement will be considered again later. Apart from this objection the arrangement has the advantage that the plots fall naturally into blocks, each containing one plot of each variety. When the advantages of "Student's method" of calculating the standard error were realised it was applied to 'chessboards.' Theoretically each unit, *e.g.*: A B C D E F G, in the repeating pattern is regarded as a set of adjacent plots, and standard deviations are calculated for every possible pair of adjacent plots A B, A C, A D, &c., B C, B D, &c., &c. The arithmetical labour involved is enormous and approximate short methods, involving the selection of a few only of the possible pairs, were suggested. The difficulty was solved by the introduction, by R. A. Fisher and 'Student,' of the Analysis of Variance, which, as indicated earlier, provides a simple and accurate solution of the problem.

Briefly stated, the total variation in yield is sub-divided into one part representing the effect of variety, another part representing differences in yield between different blocks, and a residue representing the random or uncontrolled field variation. The variation due to variety and that due to the blocks of land are simply calculated from the series of mean yields for the varieties and the mean yields for the blocks. The residue may be obtained by difference and forms the basis for the calculation of experimental error.

(*To be continued.*)

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ADCO PATENTS.

THE Manager of "Adco" Limited, Harpenden, England, writes that the interests of the Company were being damaged by the publication of abstracts of literature dealing with the manufacture of synthetic organic manures by processes which infringed on the patent rights of the Company. In view of the fact that usually no credit is given in such literature to the original discoverers of the "Adco" process, nor is any indication made of the fact that the process is patented, it is thought necessary to set down exactly what the "Adco" patent covers. It covers the following three *processes* and one sort of material namely "Adco" mixture.

(1) The *process* of making an organic fertilizer by causing soluble nitrogen (in the form of, for example, ammonium salts or urea), to combine with cellulosic materials (for example, pentosans), through the agency of micro-organisms.

(2) The *process* of employing certain insoluble but hydrolysable nitrogen compounds (for example, calcium cyanamide or waste protein such as yeast) for the same purpose.

(3) The *process* of using phosphate in different forms (for example, mineral phosphate, basic slag, superphosphate) in conjunction with soluble or insoluble nitrogen compounds described in (1) and (2).

(4) The *mixture* (sold under the trade mark "Adco") for use in carrying out the processes most simply.

The British patent numbers are 152,387 and 219,384. Corresponding patents have been secured in all the principal countries and in many small islands where not covered by patents in the parent countries. Thus, the Dutch patents protect the "Adco" processes and mixture in Java and Sumatra. In Trinidad, they are protected by patents Nos. 4 and 5 of 1924. Furthermore, it has been decided in the law courts that a person who infringes the "Adco" patents by making "Adco" for his own use, is just as liable as one who infringes by making it for sale. This definite statement should remove a widespread misconception.

When the "Adco" company was formed by Lord Elveden (now Lord Iveagh), it was clearly laid down that the Company was to be developed as a business, not a charity. In other words, it was to pay its way. If it could make a profit, that profit should be used for furthering agricultural research, and not for paying shareholders. The overhead expenditure, including advertising, has to be met out of royalties before any profit can accrue. After many years of hard labour, the Company is just self-supporting. By the articles of association, the Directors are not entitled to any payment for their services as such, so that the cost of management, so far as "Adco" Limited is concerned, is nil.

The future policy of the "Adco" Company is to arrange wherever possible for the manufacture of "Adco" mixture at centres near to the districts where the synthetic manure will be made and used. This should, in many instances, reduce freight charges on the raw materials and on the finished product, so that the cost of "Adco" mixture might be considerably reduced.

WORLD TOBACCO.

Brief History and Economic Review.

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Introduction.

THE practice of using tobacco was introduced from the New World to the Old. After an early history coloured by undue favour and undue repression, it has now established itself very firmly. Continuous expansion of production has been necessary, and, although the chief source of supply is the United States(1), tobacco is grown throughout the tropics and sub-tropics and in some parts of the temperate zones where summers are long and warm enough to support it. Consumers may like their tobacco in cigars, in a pipe, in cigarettes, as chewing plug or as snuff, and it has been found that different types of leaf have qualities suitable for the various uses, so that extension of cultivation has been accompanied by specialisation of production and manufacture. Some of the countries that are the largest producers are also the largest consumers —India and China—and only about a quarter of the world crop enters into international trade. Interchange takes place between many countries but the main current of trade is towards Europe. The United Kingdom (2) is an important consumer and tobacco, after an entertaining early history enlivened by the doings of adulterators and smugglers and the efforts of successive administrators to circumvent them and improve its quality as a revenue producer and as a commodity, has become an important item in the fiscal system. In the desire to make use of the natural resources of the Empire and to strengthen self-sufficiency, attempts were made to extend production within the Empire, and, after the war, these were aided by a substantial preference.

At first difficulties were experienced in producing suitable qualities in continuously sufficient quantities, but a more acute problem arose, that of finding a place for new tobaccos of good but different quality on markets accustomed by long usage to American types, and the whole question is reviewed in the Ninth Report of the Imperial Economic Committee, 1928.

World Production.

On the settlement of the New World the Spanish took up cultivation and in 1610 Spanish tobacco to the value of £60,000—probably 50,000 to 75,000 lb.—is said to have been imported into England. The crop was not grown by the English settlers in Virginia before 1612 but by 1616 it had become one of the staple crops of the colony(3). Cultivation was fostered in Virginia and Maryland until it became the principal commodity of exchange with the mother country and subsequently it ranked among the principal agricultural commodities of the United States. From Virginia and Maryland the pioneer settlers carried tobacco culture with them into Ohio, Kentucky and Tennessee, and it also became established in New England and Florida at an early date. Like maize, barley and potatoes, tobacco is adapted to diverse conditions, limitation of range arising principally from the necessity of protection from frost, consequently its cultivation has been widely extended, impetus having been given to other countries in the past by events like the American War of Secession and the American Civil War which curtailed the American supplies.

In the past two decades there has been a rapid increase in the production and consumption. Excluding India and China, the average production for 1909-1913 was 2,304 million lb.; for 1920-22, 2,673 million lb.; and in 1926 it was computed that 3,415 million lb. were harvested. If the tobacco of India and China is included the 1926 estimate rises to 4,900 million lb. Data relating to the distribution, trend, and volume of production are given in table I.

The United States of America and the British Empire in 1926 provided together approximately half the world total. It will be apparent from the geographical position of the producing countries that cultivation is carried on under very different climatic and soil conditions. The tobaccos, therefore, differ greatly as to the properties that determine their usefulness for different forms of manufacture, and there are wide differences in their commercial valuation.

Production in United States.

The early settlers in Virginia produced at first a single type for export to Europe, but, as cultivation was extended, it became apparent that differences in the properties of leaf, due to soil and climatic influences, greatly affected its adaptability for use in different forms. It was further discovered that the character could be influenced by the method of growing and curing. Consequently there was a tendency to specialisation in production, each district furnishing a distinctive type of leaf especially adapted for certain uses. The small leaf of dark colour, heavy body and strong aroma is closely related to the heavy clayey soils and is used for plug chewing tobacco. The lighter soils are associated with leaf of relatively large size, light colour, fine texture and weak aroma, from which cigar wrappers and tobacco suitable for cigarettes are made.

Production increased from an average of 996 million lb. for the years 1909-1913 to 1,300 million lb. for the years 1920 to 1922, while the production in 1926 stood at 1,298 million lb. Detailed analysis of the types of production shows a pronounced increase in the production of tobaccos adaptable for cigarettes, such as Burley, bright flue-cured, and Maryland leaf.

The crop is grown to some extent in a number of states, but Kentucky, North Carolina, and Virginia produce nearly 70 per cent. of the total

crop. Kentucky produces the well-known Burley, used in the manufacture of chewing and smoking tobacco, and also a dark fire-cured export tobacco; Virginia and the Carolinas flue-cured or bright tobacco, used for chewing plug, granulated smoking tobacco and cigarettes. Much of the Virginia tobacco is exported and most of the Maryland crop. The Connecticut Valley of Florida produces excellent wrapper and binder leaf for cigars, Wisconsin grows mainly binder leaf, Pennsylvania and Ohio chiefly fuller leaf. There are comparatively few large tobacco farms. Most farmers own small farms, from 50 to 150 acres, upon which they raise a variety of crops, the chief being maize, cotton and soy beans. The area under tobacco is usually from 4 to 10 acres.

Financing and Marketing of American Tobacco. The farmer may bring his tobacco carefully sorted into a few grades to open auction floors, and the purchaser may be a manufacturer's

TABLE I.

COUNTRY.		QUANTITY IN MILLION LB.			Per cent. of total Production 1926 (2).
		Average 1909-13 (1).	Average 1920-22 (1).	1926(2).	
U. S. America		996	1,300	1,298	26.5
British Empire	India	450	790	1,000	22.1
	Canada	15	30	29	
	U.S. Africa ..	15	12	19	
	S. Rhodesia ..			19	
	Nyasaland ..	5	5	11	
	N. Rhodesia ..			2	
	Australia	2	2	1.5	
	Cyprus	?	?	1.5	
China		*150*	*250*	485	9.9
Russia		236	*112*	386	7.9
The Balkans		?	?	341	7.0
Dutch East Indies		140	130	240	4.9
Japan		94	146	132	2.8
Brazil		*100*	176	130	2.7
West Indies (excluding B.W.I.) ..		110	95	127	2.6
Philippines		65	108	100	2.0
Italy		22	41	98	2.0
France		45	49	58	1.2
Hungary		105	30	57	1.2
Other Countries		—	—	—	7.0

(1) From United States Department of Commerce, Trade Promotion Series, No. 7, 1925. The *italic* figures are estimates.
(2) 9th Report Imperial Economic Committee, 1928.

representative or a buyer for resale. In any case the tobacco is taken to the packing house where it is carefully regraded. The next most common method is that of selling on the farm unassorted tobacco at a general average price. In recent years an increasing proportion of the tobacco has been packed, pooled, and sold by farmers themselves through their co-operative associations.

On the question of financing, the President of the Tobacco Association of the United States in his Annual Review of 1927 said that "The handling of the tobacco business has become a speciality with many of the large banks and they are acquainting themselves more fully with the requirements of the tobacco people, and any man in business worthy of credit can usually get what he wants from the banks with whom he does business."

The largest market for export is found in the United Kingdom which takes an average of 40 per cent. of the total exports, 75 per cent. of this amount consisting of bright flue-cured tobacco. Other important consumers are China (9 per cent.) Germany (8 per cent.) France, Italy, the Netherlands and Canada.

Consumption and Trade.

Only somewhat over one-fourth of the world crop ([4]) enters international trade channels, the rest being consumed in the countries of production. "Over three-fourths of the total export surplus of the world in 1925 was provided by the United States (39 per cent. of the total), the Dutch East Indies and the Balkans (each 16 per cent.), and Brazil (6 per cent.). The contribution of the whole of the British Empire was only about 4 per cent." (§ 4.([5]).)

A good deal of trade takes place to supply types of tobacco which satisfy the varying tastes of consumers—the United States import Turkish tobacco—but the strong current of international trade is towards Europe, which requires, in addition to its own production, about three-quarters of the surplus available from the other producing countries.

The ultimate demand arises for tobacco in various forms and important changes have been noticed in recent years—a decreased demand for cigars, and an intenser demand for cigarettes in preference to pipe tobacco.

Cigars.

The chief countries which supply the cigar leaf which enters into international trade are the Dutch East Indies, the Philippines, Cuba, Brazil, British North Borneo and Porto Rico. The trade is relatively specialised, the leaf used—especially that for the outer wrappers— is a very high grade product, requiring much skill to cure and specially favourable natural conditions to produce. Since the war, the industry has been practically at a standstill and the decline in consumption has been put down to a change in habit begun before the war and accelerated by conditions induced by the war, chiefly the inability of consumers to pay the price.

Cigarettes.

The increasing favour given to the cigarette has been noticed throughout the world and particularly in Europe. In the United Kingdom, for example, the consumption of tobacco products in 1907 was distributed as follows: cigarettes 23.8 per cent., pipe tobacco 71.1 per cent., and cigars 5.1 per cent.; in 1924 the percentages were 58.5 per cent., 40.0 per cent., 1.5 per cent. The trend developed particularly during the war years and has been ascribed to the low cost of the cigarette and its convenience as a short smoke. At the same time the more general use of tobacco amongst women gave a further impetus to the consumption of tobacco in this form.

Tobacco in the United Kingdom.

Introduction and development of the Tobacco habit.

The cultivation of tobacco and the custom of smoking was noticed at the time of the discovery of America amongst the natives, who, it is recorded, understood the fundamental principles of tobacco cultivation as now practised, and the distinctive processes of drying.

Sailors brought the habit to Europe, and, although Spain and France may have been the first European countries to use tobacco, England was the first to smoke. By 1625 it seems to have been used universally in England irrespective of class, age, or sex. At the time it was not cheap—in 1615 "the greatest part" was sold "for ten times the value of pepper, and the best of it, weight for weight with silver."([6])

Smoking had its ups and downs, and by 1700 it was falling into disfavour in the upper circles of society, but among the working classes and a few other groups—the army and the universities —the habit persisted. In the course of the eighteenth century, snuff took its place to a large extent. The introduction of the cigar, which may be attributed to the Peninsular War, first broke through the defences of the enemies. The Crimean War introduced the cigarette— "Of convenient size for a brief smoke not requiring the paraphernalia necessary to the pipe, nor leaving behind the strong odour of the pipe or cigar, it insiduously made its way everywhere, upstairs and downstairs, and sometimes even in my lady's chamber."([7]) The smokers' victory was not overwhelming, objections were registered on many sides, and only in 1868 was smoking permitted on the railways, when special compartments were provided for smokers by the Railway Bill of that year.

Position of Fiscal System. ([8])

Quite early, tobacco proved a valuable item in the fiscal system and the protection of revenue from fraud by adulterators and smugglers became

of interest to legislators. Inquiries made by Walpole and Pitt disclosed evasion and fraud on a large scale, and the dearth caused by the American Civil War made the situation acute. The gathering, cutting and curing of leaves from English woods and gardens became a practice and to facilitate the deception, the shag was dyed and stained. Pitt improved the tobacco and the health of the public treasury by instituting an excise survey but this was succeeded in 1840 by the Mixing Act which permitted anything to be added to tobacco except the leaves of trees, plants and herbs. Seeing a loophole, the manufacturers began to use various ingredients until the shag and roll sold were more in the nature of confectionery. The proportion of sugar, honey, molasses, liquorice, salt, nitre, &c., used, ranged from 50 to 60 per cent. and even the dealers could not refrain from improving on the efforts of the manufacturers. It was not until the establishment of the Inland Revenue Laboratory in 1843 that the Government was able to pass laws against adulteration with some prospect of enforcement.

Smuggling.

On account of the early prohibition of the popular Spanish tobaccos in favour of the Virginian Colonial product, and the relatively high duties on other tobacco, smuggling played a prominent part throughout the whole history of the trade. In the second half of the eighteenth century, "smuggled tobacco was openly on sale in London for two-thirds, and in the country for one-half the price at which legally imported tobacco could be sold." Except in small quantities, smuggling is now a thing of the past; the Navy took over the work of control afloat, and improved communication facilitated inland control.

The United Kingdom as a Consumer.

At one time tobacco was grown to some extent in England, chiefly in Gloucestershire, but the London Company of Virginia brought its influence to bear, and, after a series of repressive acts, cultivation was finally forbidden in 1661. The ban on domestic production was not lifted until 1886 and since that date cultivation has not really advanced beyond the experimental stage so that practically all of the tobacco entering into British consumption and trade must be imported.

Import figures from 1919-1927 are given in table II, but these must not be confused with consumption. It is a common practice to leave tobacco in stock for about two years, and the quantities of leaf removed from stock by the British manufacturers—when a correction has been made for exports—is a better guide to consumption.

"From 1919-1921 imports were abnormally heavy to replace stocks depleted during the War years. There was a fall in 1922 and 1923 followed by a steady annual growth until 1926. But in 1927 there was a sudden increase with the result that at the end of 1927 unsold stocks on

TABLE II.

GROSS IMPORTS OF TOBACCO INTO THE UNITED KINGDOM, 1919-1927. QUANTITIES IN 1,000 LB. VALUE IN £ STERLING.

	1919.		1920.		1921.		1922.		1923.		1924.		1925.		1926.		1927[1].	
	Amt.	%	Amt.	%	Amt.	%	Amt.	%	Amt.	%	Amt.	%	Amt.	%	Amt.	%	Amt.	%
Empire ..	13,952	4.0	18,210	8.3	7,460	3.3	12,654	6.8	12,895	7.5	19,273	10.6	18,921	10.0	29,795	15.1	40,949	18.4
United States ..	315,874	90.5	177,449	81.0	214,691	94.3	166,755	90.2	154,799	89.5	156,891	86.0	162,659	86.1	161,348	81.9	177,442	79.9
Other Foreign ..	19,021	5.5	23,325	10.7	5,620	2.4	5,381	3.0	5,284	3.0	6,187	3.4	7,341	3.9	5,999	3.0	3,872	1.7
Total Quantity..	348,847	100	218,984	100	227,771	100	184,790	100	172,978	100	182,351	100	188,921	100	197,142	100	222,263	100
Total Value ..	38,216		32,766		22,212		17,430		14,960		15,992		15,476		16,398		17,834	

(1) Chief sources of Empire supply in 1927: Nyasaland (13,782,000 lb.), Rhodesia (11,088,000 lb.), British India (8,432,000 lb.), Canada (5,812,000 lb.) British North Borneo (1,302,000 lb.) and U. S. Africa (249,000 lb.). (*From the Ninth Report of the Imperial Economic Committee*, 1928.)

the market were higher than usual." (§15). The amount of leaf used by British manufacturers in 1927 (including 13 million lb. manufactured in bond) was 180 million lb., 152 million (137 million plus 11 per cent. for stalks and offal), was required for smokable products in the United Kingdom. The table shows the strong position of American growths and the small extent to which Turkish, Sumatran, Brazilian, and other foreign tobaccos are used. The increasing proportion of Empire supplies—from 3 per cent. in 1921 to 18 per cent. in 1927—is noticeable, and is chiefly due to larger imports from Nyasaland, Rhodesia, and Canada.

Methods of Purchase.

The tobacco imported is either purchased in the country of production by the manufacturers or passes through the hands of merchants, manufacturers, or dealers. The general practice of the Imperial Tobacco Company—which is believed to manufacture well over two-thirds of the tobacco smoked in the United Kingdom—is to buy in the country of production. The London market has no auctions, tobacco exchanges, or 'futures' dealings, but business is conducted on the basis of 4 lb. samples drawn from stocks when the parcels are opened for customs inspection. The tobacco must be uniform throughout the bale or hogshead but transactions are not conducted on standard descriptions of quality or character. The general view of the manufacturers and dealers is that the requirements of the industry vary so much that it is necessary to see the actual sample.

The Imperial Tobacco Company.

The Imperial Tobacco Company—the largest single intermediate consumer—was formed in 1901 as a defence against the American invasion of the British market for manufactured tobacco. For a brief time a competitive struggle ensued, but as a result of this, an arrangement was effected between the British combination and its American competitor, whereby the domestic trade of the United Kingdom and that of the United States was conceded to the respective companies, and the British American Tobacco Company was formed in 1902 to acquire the export business of the competing combinations outside the United Kingdom and the United States. The constituent forms of the Imperial Tobacco Company retain their separate entities within the combination, but the Company in all matters of purchase of leaf acts as a single unit. With the exception of growing and retail sale, the activities of the Company cover all branches of the industry, the regrading in accordance with their own special requirements; the drying down of the tobacco to obtain the correct amount of moisture for shipment; the packing; the transport to the United Kingdom; the warehousing; and the manufacture and final distribution both to wholesalers and retailers. (§ 37.)

Export Trade.

The majority of the tobacco manufactured in the United Kingdom finds its way to the home market—152 million lb. out of 180 million lb. in 1927—but there is an important export trade in manufactured tobacco. This is principally within the Empire and its protectorates, consisting in the main of exports of cigarettes to India, Straits Settlements, and Hongkong, and of smoking tobacco to India, the Straits Settlements, and New Zealand. Even with some of the neighbouring countries of Europe, Great Britain has quite an important trade in smoking tobacco and cigarettes made from American leaf.

(*To be concluded.*)

REFERENCES.

(1) 1926. 26.5 per cent. of a world production of 4,900 million lb. 39 per cent. of a world export surplus of 1,240 million lb, 1925.
(2) 1927. The amount of leaf used by British manufacturers was 180 million lb.
(3) 20,000 lb. were exported in 1619 and 1,300,000 lb. in 1631.—From Rive, *Econ. Jnl.* (*Suppl.*), 1, p. 58.
(4) 1,240 million out of 4,600 million lb. in 1925.
(5) Paragraph references are to the *Ninth Report of the Imperial Economic Committee*, 1928.
(6), (7) Rive. *op. cit*, pp. 57, 64.
(8) Tanner, *Tobacco*, Pitman.

TRINIDAD SCIENCE CLUB.

The remaining meetings of the Trinidad Science Club for the session 1928-29 have been provisionally arranged as follows :—

November 29th :—
Dr. A. Clark.
"Vitamins."

December 20th :—
The Hon. Charles Sadler, General Manager of the Railways.
"Problems of Railway transportation in Nigeria."

January 31st :—
His Excellency the Governor, Sir Horace Byatt K.C.M.G.
"Administrative problems in a Mandated Territory."

February 28th :—
The Hon. Sir Francis Watts, K.C.M.G., D.SC.
"Notes on Agriculture in South Africa."

March 21st :—
Dr. J. G. Myers, M.SC. (N.Z.), SC.D. (Harvard).
"Control of parasites by biological methods."

April 25th :—
Capt. H. V. Metivier, O.B.E., B.SC., M.R.C.V.S.
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MYCOLOGICAL NOTES.

Note on the parasitism of *Macrophomina Phaseoli* (Maubl.) Ashby (*Rhizoctonia bataticola* (Taub.) Butler).

BY W. SMALL, M.B.E., M.A., B.SC., PH.D., F.L.S., *Mycologist, Department of Agriculture, Ceylon.*

WITHIN the last few years the attention of tropical mycologists has been directed to the association of *Rhizoctonia bataticola*, the soil sclerotial form of the pycnidial fungus *Macrophomina Phaseoli*, with root disease of woody plants. The soil form has been recorded of late from new areas, for example, Ceylon, Java, Sumatra, Burma and Southern Rhodesia, and Briton-Jones has reported its presence on cotton, citrus and tobacco in the West Indies. Opinions of the status or harmfulness of the fungus vary, and it is the intention of the present note to put forward the writer's point of view and to criticise certain views held in the West Indies.

Investigation of *Rhizoctonia* root disease of woody plants in Uganda and Ceylon has led the writer to two conclusions: (1) that *Rhizoctonia bataticola* is a cause of root disease, that is to say, that the fungus is able to attack and kill plants exposed to it in the soil and is therefore a parasite, and (2) that, when it is found in the company of another fungus (or fungi) in cases of root disease it precedes the other form (or forms) in time of attack and is therefore primarily responsible for root disease. Those views were published in 1927 ([1]). They were based mainly upon the facts that in numerous instances *Rhizoctonia* could be shown to be in sole association with cases of root disease and death, that *Rhizoctonia* was present in all cases in which other fungi like *Fomes, Poria, Diplodia, Ustulina* and *Rosellinia*, the supposed causes of root disease were present, that it might be doubted if the accompanying fungi ever occurred without the *Rhizoctonia* and that there was field evidence of the precedence in time of attack of *Rhizoctonia* over the fungi mentioned and of the secondary nature of the other fungi. Attention was drawn also to the significance of the method of entry of *Rhizoctonia* into its host, that is, by the smallest feeding roots, and to the comparative lack of experimental proof of the parasitism of the fungi which have been recognised in the past as causes of root disease. It was admitted that experimental proof of the parasitism of *Rhizoctonia* was not large and complete, and it was announced ([2]) that efforts were being made to supply the deficiency.

The writer's conclusions have been criticised from two points of view: (1) that *Rhizoctonia* is a saprophytic form and is entirely incapable of parasitism, and (2) that the parasitism of *Rhizoctonia* is dependent to such a degree upon the presence of contributory or preliminary conditions which affect the host plant adversely that the fungus may be regarded as a weak parasite or one that is harmless in the absence of the contributory conditions. The second view is that held in the West Indies, and attention will be confined to it in this note. The other view and its implications have been criticised ([3]), and further attention will be devoted to it in due course.

Briton-Jones has recorded *Rhizoctonia bataticola* in the West Indies and has offered certain comments on the writer's views and conclusions ([4], [5], [6]). He thinks, for instance, that the statements that: "*Rhizoctonia* root disease will "always occur when the fungus is in the soil" and that "the only measure that can be "recommended to the practical planter is that "he should promote the health of his plants by "all means in his power" ([1]) are contradictory. He implies that there is little gain in promoting the health of plants which will fall victims to the attack of *Rhizoctonia*. The criticism might be justified if it were the case or if the writer had suggested that every plant exposed to *Rhizoctonia* succumbed to attack. It is probable that in nature, resistance to *Rhizoctonia* attack occurs and that the number of plants killed eventually by *Rhizoctonia* is only a small proportion of those exposed to attack. The irregular manner in which many cases of *Rhizoctonia* root disease occur in areas of, for example, tea and rubber points to the possibility of resistance to the fungus on the part of plants adjacent to diseased plants and therefore exposed to the fungus in the soil, and thus to the probable usefulness of measures designed to produce and maintain the healthiest possible plant. Further, it is possible that the really healthy and vigorous plant may be able to avoid *Rhizoctonia* invasion of its rootlets by active growth or resist the entry of *Rhizoctonia* or hold the fungus in check even after entry.

A second point of disagreement is the statement that *Rhizoctonia* root disease will always occur when the fungus is in the soil. Briton-Jones bases his objection to it on the ground that the placing of the fungus in the soil in infection experiments fails to cause disease, but the writer does not find the objection to hold. It is possible that Briton-Jones' infection experiments were not allowed to run for a sufficiently long period and that sufficient opportunity for the fungus to attack and enter the feeding rootlets of the intended host plants was not given. The above-ground symptoms of *Rhizoctonia* root invasion require a comparatively long time for their appearance, and it has been found that examination of roots exposed to the fungus, especially those of plants which are not dying or palpably diseased, must be close and exhaustive. In fact it is possible that, in many cases which a cursory glance or superficial examination would dismiss as negative or devoid of results, infection has actually taken place in the sense that the fungus has entered the root tissues of the host plant. Although the sclerotia of the fungus may require a resting period after being placed in the soil in inoculation experiments, a probability that is supported by the frequent difficulty of causing sclerotia taken

from diseased roots and from cultures to germinate quickly, the possibility of the slow advance of the fungus in invaded roots is also present. It may be added that Briton-Jones is not correct in his statement in (3) that the writer's experiments with *Rhizoctonia* in Uganda were devoid of positive results. Certain results were reported in 1926 (7).

Experimental infections have been obtained at Peradeniya, an account of which will be published elsewhere. *Rhizoctonia* attack on tea, cacao, lime, dadap and rubber seedlings, young coconuts, plantains (bananas) and a pot of chillies has been encountered. There is no doubt that the fungus can force its way into roots exposed to it, and the condition of the control plants points to the fact that contributory conditions have not been in action. Experiments with seedlings in pots and with adult tea and other plants also show that *Rhizoctonia* infection takes place at one point only, namely, the feeding rootlets. It follows that a conclusion such as that made by Briton-Jones (3) from his infection experiments on adult jute to the effect that the fungus "is a weak parasite of the adult jute plant," is based on the results of a method of infection which the fungus does not use under natural conditions and is therefore unsound. His experiment showed that the fungus was a weak parasite of wounded jute stems and nothing more. Soil inoculations of jute were reported to give negative results. The plants may have been resistant, but, again, inoculation of the soil with large numbers of *Rhizoctonia* sclerotia before planting the seed might have given a different result. The method used by the writer consists in growing the fungus on slices of sweet potato which are converted into Taubenhaus' charcoal rot in a few weeks, mashing the masses of sclerotia in boiled distilled water and watering the resultant fluid at the desired depth into the soil to be inoculated.

Similarly, a conclusion drawn from the recovery of camphor and rubber from dieback in St. Lucia (6), a district liable to drought in which plants "dieback in most years" to the effect that "even if *M. Phaseoli* was at a later date found "on their roots, this would *ipso facto* supply "further evidence to show that this fungus is not "a primary parasite," may be objected to on the ground that it is not proved that the fungus attacks *follow* the effects of drought on the trees. Further, it ought to be shown that the recovery from dieback is not merely of a temporary nature though spread over years. Rubber, for instance, when affected by *Rhizoctonia* can produce new roots to replace losses, an observation made by Hansford in Uganda and the writer in Ceylon. The diseased tree may thus prolong its life and make it possible that successive leaf-falls and diebacks may be as much the result of root disease as of external unfavourable conditions of a temporary nature.

Objection has also been raised to the writer's separation of the factors or groups of factors involved in the causation of root disease into immediate and ultimate, the immediate factor being the fungus which attacks the plant and the ultimate factor the conditions which enable the fungus to attack with success. These two factors are said to overlap and the terms immediate and ultimate are said to be redundant. If it is meant that the two factors, environment and parasite, are so bound up in each other that the fungus cannot act in the absence of contributory conditions, it may be pointed out that it is doubtful if contributory conditions are in invariable action before or during the time of entrance of *Rhizoctonia* into the root tissues. On the other hand, the factors may overlap or be interdependent in operation in nature but that fact does not preclude the distinguishing of the one from the other and their separate consideration. As has been said recently in an American publication (8), the cause of disease has been broadened in its interpretation. The potential parasite may be termed the primary or causal factor; the limiting environmental conditions may be termed secondary or conditioning factors. From this point of view the terms immediate and ultimate or primary and secondary cannot be regarded as redundant, for, to quote from the American publication mentioned, "the "associated abnormal host conditions which we "term 'diseases' are the resultants of the "interaction of a plastic host and a plastic "parasite under the play of variable environment." It may be said perhaps, that the writer has given the impression that in the case of *Rhizoctonia* root disease he considers that ultimate or secondary conditioning factors, if such exist, are of little or no account, but that has not been his intention. The need for investigation into the conditions of the parasitism of *Rhizoctonia bataticola* has been kept in mind and has been mentioned on various occasions; the importance of the need is recognised in full. In fact, it was the study of the conditions under which *Rhizoctonia* was parasitic in Uganda that led the writer (7) to draw attention to the fact that, so far as known, *Rhizoctonia* attack was confined to introduced plants in that country and to wonder if the fact had any significance. It was not asserted, however, that the fungus could not attack indigenous plants; it was only presumed that the indigenous flora was immune.

Briton-Jones also objects to the importance attached by the writer to the pycnidial stage of *Rhizoctonia bataticola* (which is now known as *Macrophomina Phaseoli* (Maubl.) Ashby) on the grounds of difficulty of control of the pycnidial stage and preference for elimination of the growth factors which predispose to *Rhizoctonia* disease. The finding of the pycnidial stage of the *Rhizoctonia* is proving a difficult matter and the destruction of it may prove to be far from easy, but, in the present state of our knowledge, it is surely wise to endeavour to attack the *Rhizoctonia* problem from as many sides as possible. The necessity for this course is the greater when there is doubt concerning the existence of predisposing factors. It is conceivable that the discovery of sources

of the pycnidial stage (found hitherto in Ceylon only on beans and sunflower and in culture) may lead to the control, partial no doubt but nevertheless useful, of sources of supply to the soil of a fungus which is so widely distributed in Ceylon and which is associated with so much root disease.

These points raised by Briton-Jones lead up to the point of greatest importance, that special conditions which affect the host plant unfavourably are required for infection by *Rhizoctonia bataticola*. He bases his assertion on the difficulty of obtaining rapid results in experimental inoculations and on certain observations, and he places the fungus in a position secondary in significance to that of the contributory conditions. In fact, he states in another place ([3]) that the contributory conditions "are such that they in themselves thoroughly "upset the metabolism of the plant before it is "attacked by the fungus. In other words, the "fungus *Macrophomina Phaseoli* (*Rhizoctonia* "*bataticola*) is itself a secondary factor in the "causation of disease, and, from the point of view "of control, operations must aim at the elimination "of these fundamental and primary factors. "This will render the fungus, although it may "still be present in the soil and distributed as "spores, completely innocuous."

This view which, in the writer's opinion, ought to be supported by adequate experimental proof of the essential inactivity of *Rhizoctonia* under conditions favourable to the possible host plant and of its necessary pathogenicity under conditions unfavourable to the host means that there will be no *Rhizoctonia* root disease if the conditions which enable the fungus to attack with success are ameliorated or removed. It may also be taken to imply that, in the absence of conditions unfavourable to the host plant, no *Rhizoctonia* disease will occur even in the presence of the fungus. It is necessary to understand clearly that the point under discussion concerns the priority of the action of contributory conditions or a physiological check over *Rhizoctonia* attack, and is not concerned with the possible action of external conditions which may aid the advance of *Rhizoctonia* after it has established itself in root tissues. Briton-Jones brings forward evidence of the activity of unfavourable plant conditions in Dominica which lead to *Rhizoctonia* disease, a particular instance being that of disease of the roots of seedling limes. The conditions in question consist of a preliminary attack on the roots by insects, the damage done by which enables the fungus to gain a footing in the roots. Apart from the fact that there is no proof of the priority in time of insect attack over fungus attack, attention must be drawn to the fact that in Ceylon cases of *Rhizoctonia* root disease in both field and experiment do not show the workings of contributory conditions as plainly as the West Indian case cited. Conditions of soil moisture and temperature, for instance, do not seem to play a regular and constant part. Cases of *Rhizoctonia* disease of tea have been obtained from elevations ranging from more than 6,000 feet to near sea level, cases of *Rhizoctonia* root disease of coconut palms from the sand of Mannar and the good coconut soils of Negombo and Kurunegala, and cases of rubber *Rhizoctonia* disease from stony slopes, swampy areas and rich well-drained soils. If, again, an unsuitable soil reaction is in operation, it may be expected to affect many more plants than the numbers actually affected by *Rhizoctonia* disease. In tea, rubber and coconuts, isolated cases of *Rhizoctonia* root disease can be found in the midst of large fields of apparently healthy plants. If conditions are wrong for the plants which prove to be diseased, they may be expected to have unfavourable effects on neighbouring plants and lead to *Rhizoctonia* disease provided, as is possible, the distribution of the fungus in the soil is greater than the actual cases of disease indicate, but there is no evidence of their doing so. If only a few plants succumb to *Rhizoctonia* root disease as happens frequently, and if neighbouring plants appear to be perfectly healthy as is usual, it may be concluded that the adverse conditions do not affect them seriously on the whole and that the incidence of disease is determined more by the presence of the fungus than by the action of conditions of growth. Also, if conditions are unsuitable for the plants actually attacked and killed by *Rhizoctonia*, it may be concluded that much tea and rubber adjoining attacked plants is growing under wrong conditions in Ceylon, an assumption which, on the whole, is not borne out by the appearance or yields of these crops in the particular cases in question. Further, it does not follow that conditions favourable or unfavourable to the host plant are respectively unfavourable or favourable to the fungus. It has been shown ([8]) that favourable conditions for the host plant may also be favourable to the fungus, and it is possible that conditions unfavourable for the growth of the host are unfavourable also for the fungus.

On the other hand, it is possible that, in cases of large outbreaks of *Rhizoctonia* root disease or outbreaks among the young plants of new clearings, adverse soil conditions may be found to be in operation, but here again difficulties can be raised. Single plants or groups of plants may be unaffected by root disease in such circumstances, and while unaffected plants may be more resistant than others or more adaptable to the particular conditions of growth, there is a possibility that they owe their continued existence to the fact that their roots have not encountered the fungus in the soil. Again, contributory conditions may vary greatly even in the same field. If so, it must be concluded that their amelioration or elimination will present a problem of great difficulty as far as the many acres of the planter are concerned, and it follows that the importance of the presence of the fungus becomes relatively greater, perhaps greater than that of possible contributory conditions.

The fact remains that infection occurs frequently in nature in Ceylon and has also been obtained in experiment under circumstances which do not point clearly to the existence and working

of contributory conditions. In this connection it should be remembered that *Rhizoctonia* root disease has occurred on indigenous Ceylon plants which were not growing in an entirely unsuitable environment. Briton-Jones' point is that *Rhizoctonia* root disease follows a physiological check which interferes with the metabolism of the plant; the writer's point is that the physiological check which is supposed to be the forerunner of *Rhizoctonia* root disease is not apparent under Ceylon field or experimental conditions and that he cannot accept at the moment the view that contributory conditions are all-important and the fungus of little account, that the former are ameliorable and the latter may therefore be ignored.

The following points which affect the question of preliminary contributory conditions and *Rhizoctonia* root disease have been brought to light recently. The first point is that *Rhizoctonia* has been found by Park ([9]) in a mycorrhizal or endophytic condition in tea rootlets, and the second is that the fungus has been isolated by the writer and Ragunathan from the cortex of larger tea and rubber roots which appear to be perfectly healthy and which belong to plants which show no outward signs of root disease. The Endophyte of tea roots may form a true mycorrhiza, but it has to be remembered that the nature of a mycorrhiza is in dispute, that the fungus has to *attack* the plant before a mycorrhiza can be formed and that certain authorities hold that the mycorrhizal condition is one of parasitism of the fungus upon the plant root, albeit parasitism of a weak or suppressed kind. Whether the tea endophyte found by Park is a partner in a true mycorrhiza or not is not yet determined. It may be doubted if it is a true mycorrhiza in the sense that the symbiotic condition is lasting or obligate. Again, symbiosis has been shown to have turned into parasitism, and, as Waksman ([10]) has pointed out, gradations in the relations between plants and micro-organisms are found between strict parasitism and strict symbiosis with an intermediate mutual parasitism.

At this point, the following points ought to be taken into account. *Rhizoctonia* can be found to have killed the roots, even the smallest, which it has entered, and it can be found in and isolated from the larger healthy roots of healthy plants of tea and rubber as if it had passed into them from the smaller roots. It is possible, therefore, that the death of smaller roots followed by the death of larger roots and eventually of the whole bush or tree is a natural sequence of the presence and advance of *Rhizoctonia*. On the whole, it may be doubted if the behaviour of the fungus is that of a true mycorrhizal fungus or, indeed, of anything but a parasite. The parasitic view is supported by examination of the roots of infected seedlings. On the other hand, it is possible that the plant may hold the fungus in check after the latter has entered the roots and that a balanced condition of mutual tolerance may continue for a long time or even throughout the lifetime of the plant provided that nothing arises to interfere with it and give an advantage to either plant or fungus over the other. While, therefore, it is possible that the endophyte may be able to advance into the root tissues on a parasitic career when adverse conditions affect the host plant and that its presence in larger roots is the result of its advance from smaller roots, it is also possible that the endophyte is harmful *ab initio* and that, although its progress is slow and subject to checks put upon it by the plant, it is comparatively steady and sure in its eventual results. The writer has always held that *Rhizoctonia* enters its host by the smallest feeding roots and that its subsequent advance is slow, and it should be noted that a true mycorrhizal condition with its accompaniment, the continued healthy condition of the affected plant, has not been encountered among the writer's experimentally-infected plants.

In any case, these two points militate against the acceptance of Briton-Jones' view that *Rhizoctonia* disease can only *follow* a physiological check to the activities of the plant such as he evidenced and against the view that *Rhizoctonia* is a common soil saprophyte. A saprophyte does not adopt living, apparently healthy roots as a substratum for growth, nor is it found in dead roots which can have been killed only by itself. They also point to the need for a very careful examination of roots exposed to *Rhizoctonia* in nature or in experiment in order to determine if the fungus has entered the host plant. Plants that do not look like cases of infection may prove and have proved to be infected after all.

Generally speaking, it may be doubted if Briton-Jones' claim that the writer "has made "statements which are not in accordance with "the true facts" can be justified. The deductions leading to the supposed true facts are hasty and open to criticism. The conditions found in the field in Ceylon in, for example, tea and rubber, in both of which crops numerous cases of root disease can be found with *Rhizoctonia* in sole association and with no contributory conditions in operation, have been reproduced in experiments with woody seedlings of tea and rubber growing under favourable conditions and there seems to be reason why *Rhizoctonia* should be regarded as a parasitic fungus capable of attacking and killing without the intervention of contributory conditions host plants exposed to it in the soil. It is also doubtful if Briton-Jones' generalisation regarding the necessity for contributory conditions and the consequent weak parasitism of *Rhizoctonia* will stand the tests to which it ought to be put. Further, if West Indian conditions are invariably like those described in the case of the Dominica lime root disease, they are more easily seen and more universal in their action than Ceylon conditions, but it should be noted that West Indian investigation has not been extended to the roots,

especially the smallest roots and the feeding rootlets, of the large numbers of adult woody trees and woody seedlings that have been examined in Ceylon.

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Comments on the above Note.

BY H. R. BRITON-JONES, D.SC., PH.D, D.I.C., A.R.C.S.

THE above note is one of many interesting and important articles which have recently been published by Small on the fungus *Macrophomina Phaseoli* (Maubl.) Ashby. Experience with the same organism in Egypt and the West Indies led the writer to conclusions which differed from those drawn by Small as the result of his work in Uganda and Ceylon. The main difference in our views is that Small states that *Rhizoctonia* root disease will always occur when the fungus is in the soil" whilst the writer holds that *Macrophomina Phaseoli* is a parasite on the roots of various host plants but that its parasitism is dependent on other factors which affect the host plant in such a manner as to predispose it to infection. There is no great need for the writer to search for evidence in his own experiments and observations to support his own view since Small has very ably done this in paragraph 4 of the above article as follows :—

> "Briton-Jones has recorded *Rhizoctonia bataticola* in the West Indies and has offered certain comments on the writer's views and conclusions ([4], [5], [6]). He thinks, for instance, that the statements that '*Rhizoctonia* root disease will always occur when the fungus is in the soil' and that 'the only measure that can be recommended to the practical planter is that he should promote the health of his plants by all means in his power' are contradictory. He implies that there is little gain in promoting the health of plants which will fall victims to the attack of *Rhizoctonia*. The criticism might be justified if it were the case or if the writer had suggested that every plant exposed to *Rhizoctonia* succumbed to attack. It is probable that in nature resistance to *Rhizoctonia* attack occurs and that the number of plants killed eventually by *Rhizoctonia* is only a small proportion of those exposed to attack. The irregular manner in which many cases of *Rhizoctonia* root disease occur in areas of, for example, tea and rubber points to the possibility of resistance to the fungus on the part of plants adjacent to diseased plants and therefore exposed to the fungus in the soil, and thus to the probable usefulness of measures designed to produce and maintain the healthiest possible plant. Further, it is possible that the really healthy and vigorous plant may be able to avoid *Rhizoctonia* invasion of its rootlets by active growth or resist the entry of *Rhizoctonia* or hold the fungus in check even after entry."

The writer is in entire agreement with this statement of Smalls' and stresses the point that the word "resistance" must have only one meaning, namely, the physiological conditions of the tissues which may be temporary as against the more permanent and inherent quality of resistance due to anatomical or biological differences between the diseased and attacked plants. Unless this is so the last sentence becomes an absurdity.

In the next paragraph Small suggests that the writer's experiments were possibly not allowed to run for sufficiently long a time. The writer would point out that they were run for sufficiently long a time to allow the crop in question to ripen. Successful infection after that time is not of great significance to the writer. Furthermore, under field conditions and incidentally under experimental conditions seedlings five days old from sowing, and woody plants of all ages, can become infected by *M. phaseoli*. This stressing of the time factor by Small is possibly of significance. One wonders why Small goes out of his way to state that a plant may have a diseased root system without its' showing outward and above ground symptoms, and that examination of diseased root systems should not be cursory but close and exhaustive. He also pointed out these elementary facts in his answers to criticism by mycologists in Ceylon.

In his criticism of the writer's experiments on jute Small reads more into the written statements than is justified. As explained, the stem inoculation experiments were carried out with various isolations of *Rhizoctonia bataticola* (Taub) Butler not primarily as a test of parasitism but as a ready means of obtaining the pycnidial form *Macrophomina Phaseoli*. Small agrees, however, that the fungus was a weak parasite of wounded jute stems and nothing more was concluded by the writer until soil inoculations of jute were carried out.

In paragraph 7 Small finds objection to the writer's statement on the ground that it has not been proved that the fungus attacks *follow* the effects of drought on the trees. It has been proved and demonstrated by more than one worker that Die-Back of Cocoa in the West Indies is primarily due to external factors rather than to the results of primary infections by *Diplodia* or the *Phomopsis* spp. which the writer had under discussion. The fungus *M. Phaseoli* has not as yet been associated with Die-back of Cocoa in the West Indies nor yet with Die-back of fruit trees in Europe.

In regard to the terms primary and secondary or immediate and ultimate perhaps the best means of clearing the point is by the simple means of substraction. For example, in the case of a true parasite like the Black Rust of Wheat the cause of the disease is the fungus *P. graminis* and factors influencing adversely the wheat plant are not essential for successful infection. In this case *P. graminis* is the primary cause of the disease. On the other hand a pathological or diseased condition of a plant can be induced by waterlogging, drought effect, manurial deficiencies, &c., to the exclusion of any organism. In this case the primary cause would be waterlogging or the manurial deficiency as the case might be. In the case of Wheat manured excessively with nitrogenous manure the tissues become more susceptible to attack by the fungus. In this case the excess of nitrogenous manure is a contributory or secondary factor. On the other hand following waterlogging, drought effect, or manurial deficiency the host plant may be brought into a condition which renders it susceptible to attack by weakly parasitic organisms which would be secondary factors in the disease complex. Small and the American writers quoted by him appear to generalise too much, therefore, when they state that the potential parasite is the primary factor, and that the limiting environmental conditions are the secondary factors. The organism and the environmental conditions can be primary or they can be secondary. Which of the two is the primary and which is the secondary in any particular case of disease must be decided after investigation. Furthermore, after the decision has been arrived at, use can often be made of the knowledge in regard to the primary factors and in other cases of the secondary factors to indicate the means of control.

The writer agrees with Small who suggests that conditions unfavourable to the host plant can also be unfavourable to the potential parasite. An autoclave at a temperature of a 100°C would be a fair example of this.

In conclusion it may be of interest to state that the question of the physiology of the parasitism of *M. Phaseoli* will be investigated this year at this College and it is hoped that it will be possible to solve satisfactorily what is at the moment little more than merely a matter of opinion.

INDIAN CANES.

Classification and Origin.

By C. A. Barber, C.I.E., D.Sc.

Systematic botanists have noted that there is a close connexion between the various forms of sugar cane, termed collectively *Saccharum officinarum*, and a wild species *S. spontaneum* widely spread over eastern Asia, but perhaps reaching its greatest development in north India; and it has become customary to regard the sugar cane as derived from this grass or an allied species of *Saccharum* not yet met with. But for those who have had the opportunity of studying representative collections, it has always been a mental strain to include the thin, hardy canes of north India with the thick, juicy tropical forms under one species. There is certainly some ground for assuming that Indian canes may have been derived from *S. spontaneum*. In the Punjab the local cane most widely grown (Katha) is sufficiently like the wiry *kans* grass (the local form of *S. spontaneum*), for the intelligent cultivator to point to it as the wild ancestor; and on the banks of the Hooghly near Calcutta, at the opposite end of the Indo-gangetic plain, a thicker, juicier form exists which is stated to have been formerly chewed by children and even sometimes crushed for its sweetish juice. Analyses of one of the seedlings raised at Coimbatore from this variety showed over 8 per cent. of sucrose, a proportion not far below that in some north Indian canes. This close resemblance between the wild Saccharum and the cultivated sugar cane is only met with in some groups of the indigenous Indian canes, and its likeness to tropical canes is more remote. The Indian canes might, conceivably, form a connecting link between *S. spontaneum* and the ordinary sugar cane; and a considerable amount of time was spent by the writer in attempting to frame a series of transitional stages between Indian canes and those of the tropics. This study, although extremely interesting and throwing much light on the characters of some of the northern canes, ended in a medley of isolated groups and doubtful varieties, it being impossible to decide whether some of the latter were indigenous to India or canes introduced from warmer regions and long grown in the country. No decision was reached, and it was ultimately thought to be more probable that, as had been often suggested before, the Indian and tropical canes had arisen independently and, further, that the change from the wild to the cultivated stage had taken place in entirely different parts of the East. It was concluded that the Indian class may have arisen in the moister parts of India (Bengal and Assam), and the tropical class in some of the larger islands of Oceania, quite possibly in New Guinea, where such a wealth of new forms had recently been discovered by Australian explorers.(1)

This result was primarily based upon an exhaustive study of differences in the morphological characters of the vegetative organs of the

sugar-cane, some of these characters being very minute. In the absence of a suitable library and an authoritative herbarium, the current classification of the Saccharums and allied grasses was accepted, although it was felt that considerable revision was needed; and a large collection of the arrows of cane varieties flowering on the cane breeding station at Coimbatore was got together for further study. No opportunity was afforded, however, for working up this material.

It is a matter of great satisfaction, then, that the genus Saccharum has been recently overhauled by Dr. J. Jeswiet, formerly head of the Botanical section in the Java sugar station.(2) Jeswiet was placed in a better position than any of his predecessors for this classificatory work, in that he was not dependent, as they were, upon the often casual collection of specimens in the chief herbaria; but had studied the living plants in their natural habitat for many years. He has, moreover, made notable contributions to the difficult task of distinguishing the different kinds of sugar-cane grown in the tropics. We see here an example of a general principle which has frequently forced itself on the attention of the writer, while studying the flora of the tropics; namely, that the time has come when systematic work in the herbaria must always be supplemented by a study of the living plants in their natural habitat. This is of course, a matter of great difficulty for most parts of the tropics, but it is specially necessary in the case of cultivated plants.

Jeswiet's paper is much too technical and condensed for analysis here. It will suffice to note that, by a minute examination of the inflorescences, always the safest basis in classification, if obtainable, he has provided a radical re-arrangement of the genus Saccharum. The general result is the removal of all the wild north Indian grasses hitherto placed under Saccharum to allied genera, save only *S. spontaneum*; and the separation of some of the indigenous canes of north India from *Saccharum officinarum*, which is retained for tropical forms. Two north Indian canes are raised to the status of separate species—*S. sinense* with example Uba, and *S. Barberi* with Chunnee as type.

This piece of work is most opportune and important, and considering the qualifications of the author, may be taken as authoritative. It lays a firmer foundation for the scientific study of the sugar-cane varieties, the correct naming of which is now becoming of such great economic value, than has ever existed before; and Jeswiet has done a real service in showing that, by using the inflorescence, there are sound reasons for separating the two great classes of canes in the systematic scheme. Similarly, it has always been felt that the likeness of *S. spontaneum* to the cultivated forms was out of all proportion greater than that of *S. Munja, arundinaceum, fuscum* and even *Narenga*; and it is comforting to know that the four latter species are more or less negligible botanically in one's researches into the origin of the sugar-cane, being safely tucked away under another genus.

It must not be thought, however, that the matter ends here. This departure provides for only two of the Indian canes, which have strayed from their original habitat to the tropics; and it has been shown that there are a number of other forms left, which have as distinctive characters as those mentioned. These still await examination along the lines laid down by Jeswiet. Some spade work has been done in India on its indigenous cane varieties, one result of which has been the segregation of five main groups, provisionally called Mungo, Saretha, Sunnabile, Pansahi, and Nargori, after well known typical members.(3) As Chunnee is a representative Saretha form, and Uba, although not grown in India under that name (which is Brazilian) is indistinguishable from members of the Pansahi group, we must presumably include all the Saretha group under Jeswiet's species *Barberi*, and all of the Pansahi group under *sinense*.

A criticism may be inserted here of the selection made by Jeswiet of the specific name for Uba, in that the opportunity has been missed of correcting Roxburgh's pardonable mistake regarding Chinia, a member of the Pansahi group in north India. While Jeswiet tacitly verifies the writer's identification of Uba with the Pansahi group, the specific name *sinense* for this cane (and its American variants) suggests an origin in China (or Japan). There are no indigenous sugar-canes in Japan, which includes the Loochoo Islands and Formosa in which the sugar-cane is cultivated. It is well known, however, that the sugar-cane was introduced into China from India, many centuries ago it is true, but at a comparatively recent period in the history of these eastern countries. Noel Deerr, has recently had opportunities of studying the literature on Indian canes, and I am in full agreement with the views which he holds.(4)

The five groups of Indian canes mentioned above are to all appearance natural ones. They were first instituted by the simple method of arranging the Indian varieties brought together at Coimbatore for seedling work, according to their obvious similarities in growth and habit. Later, to a close study of their flowering habits and powers of producing seedlings, was added that of the morphological characters of their vegetative organs, whereby a certain amount of shuffling and re-arrangement was made possible. But this study was only brought to a conclusion in two groups, namely the Saretha and Sunnabile, these groups having robust representatives in south India, which were being used for crossing and were difficult to separate. Because of certain characters which these canes had in common with *S. spontaneum*, this species was also examined at the same time.

Another reason for selecting these groups for a special study was the fact that the close resemblance of the members to one another,

which is so striking a character in the other groups, was entirely absent, so that it was specially difficult to get them properly arranged. This study naturally developed into a detailed examination of the value of such characters, many of them extremely minute, in separating cultivated sugar-canes. The results were put together in the form of a Memoir([5]) ; and it was hoped that the method might, in time, be applied to the members of each of the other groups : then to those Indian canes which could not be placed in any of the groups and which were provisionally collected in an "unclassified" section : and lastly to the homogeneous group of tropical forms, wherever a representative collection of them could be met with. The writer still holds the view that, in cultivated plants, the true method of studying the inter-relation of varieties lies rather in the examination and comparison of a multitude of vegetative characters than in the selection of one or two only, whether in the inflorescence or in any individual vegetative part ; and that this is especially the case with plants long reproduced by the vegetative method. The use of individual characters in such a case is rather in preparing "Keys" for rapid and easy separation than in tracing the lines along which development has taken place.

The number of characters finally chosen in the analyses of the Saretha and Sunnabile groups was 66. Others continually cropped up during the course of the work, but it was soon realized that these could be indefinitely increased in number, and would only be limited by the time at the disposal of the student—witness the remarkable development by Jeswiet in his study of the hairs on the buds of sugar-canes ! It must be remembered also that a whole series of characters of importance would be obtained by a study of the histology and pathology, besides ecology, cropping, milling and factory work ; and these would have received attention had they been available. But in the 66 characters used it became of importance to separate those of major and minor importance, according as they occurred in all of the members or only in the majority, and this separation was given prominence in the Memoir. As for the examination of the other groups, it is satisfactory to note that it is highly probable that the number of characters requiring study would be far fewer, because of the closer relation to one another of the members.

Such a study is inevitable if we are to get a thorough knowledge of Indian canes. Some of the unclassified list will possibly find their place in one or other of the groups, or serve as connecting links between them ; new minor groups will be formed, and outstanding anomalous varieties, possibly of comparatively recent origin, may prove valuable in indicating the lines along which new groups are formed. It is in fact permissible, in conclusion, to put down certain ideas which have arisen in the study thus far made.

The Saretha and Sunnabile groups are spread throughout the country, and the members have had time to adapt themselves to their special conditions : these groups then probably originated many centuries ago. It may be noted, in this connexion, that Uba has probably been for some hundreds of years in the tropics, and yet it is indistinguishable from certain members of the Pansahi group in north India after the closest examination. The Saretha group shows marked resemblances in certain characters to *S. spontaneum*, so that it is quite possible that it originated from that wild species or that the two arose from a common ancestor. Sunnabile, although also found all over India, is much more homogeneous, and has many characters in common with the green section of the Saretha group, as contrasted with the red-brown (*S. spontaneum* also has its green and red-brown sections). Sunnabile may thus have arisen as an offshoot from a green member of the Saretha group ; and its more recent origin is supported by the much greater homogeneity of its members than in the Saretha group, thus providing less time for differentiation.

Pansahi, Nargori and Mungo groups, all show great homogeneity and have a restricted range. They would be, according to this reasoning, comparatively recent developments, but in the absence of a careful examination of their vegetative characters we enter the field of speculation. In spite of major differences, certain links may be found between Mungo and Sunnabile, suggesting a possible genetic connexion between these two ; and the Mungo group is more like a tropical cane than any of the others ; but one hesitates to carry the speculation further. All of these groups are markedly sterile. The Pansahi canes show infertile anthers and do not easily produce seedlings when crossed. Mungo did not flower while these studies were in progress, but is reported to have done so since. Nargori only produces malformed inflorescences. And a correspondent has recently suggested to the writer that the infertility of Uba may possibly be due to a hybrid origin. Male or female impotence is common enough among cultivated canes, and one would hesitate in ascribing it generally to their hybrid nature : it might have something to do with long disuse during vegetative reproduction. This subject cannot be explored, within the limits of the present article, without an analysis of the leading characters of the groups of Indian canes, although it is worth keeping in mind.

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2. *Bijdrage tot de systematik van het geslacht Saccharum. Beschrijving der soorten van suikerriet*, 11 *de Bijdrage, Mededeelingen v.h. proefstation de Java-suikerindustrie*, 1925, No. 12. (*Archief* 1925, pp. 391-404). This paper has only recently been seen by the writer.
3. *Agricultural Journal of India*. Vol. XI, Part IV, Oct. 1916, and *Memoirs of the Department of Agriculture in India*, Botanical series, Vol. X. No. 2, June, 1919, pp. 133-151.
4. *International Sugar Journal*, 1927, pp. 314, 519.
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TROPICAL WORLD NOTES.

The British Cameroons.

The British Cameroons lie between Nigeria and that part of the former German Cameroons which is now administered under mandate by France. The total area is 34,236 square miles and the total population is 700,050. The nature of the country varies from sandy areas, coastal mangrove swamps and thick forest belts to grass lands at heights of 4,000 to 7,000 feet and over. The principal exports are dried bananas, cocoa and rubber. The weight of dried bananas exported in 1927 was nearly doubled while rubber also showed a very large increase.

The Superintendent of Agriculture proposed a cocoa fermenting scheme in 1926 whereby fermenting houses were to be erected at certain centres under the management of an African Agricultural officer. Other objects of the scheme included the weighing and recording of all wet cocoa brought by the farmers, the marketing of the fermented and dried cocoa and the regular distribution of the profits to those concerned. Although, at first, the majority of growers expressed themselves as being in favour of this scheme and many applications for the erection of cocoa drying houses had been made, a sudden reversal of public opinion occurred, the precise cause of which is not known, and the scheme was no longer looked on with favour. In spite of lack of general support, however, one cocoa shed was actually in operation in 1927 and three others were approaching completion at the end of the year. Practically all native grown cocoa is purchased by firms and fermented and dried on their own premises. Cameroons cocoa, whether from the plantation companies or the trading firms, maintains a very high grade. The labour supply on all kinds of plantations has continued to be surprisingly good and there has been an increase in the proportion of labour coming from tribes in the British sphere and a decrease in those from the French sphere.—(1927 *Colonial Report*, No. 34.)

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Gold Coast.

Native cocoa planters on the Gold Coast, who have been passing through a somewhat bad time, are endeavouring to overcome their difficulties by organizing their trade on a co-operative basis, forming local combines. Several of these groups recently sent a representative to Europe with a view to arranging the direct sale of their produce, dispensing with intermediaries. It is now announced that Mr. A. S. Cann, their representative, who has been in Holland for some time in this connection has succeeded in forming a company to manage the sales at the European end. This company, which has the support of a group of Dutch banks, will have a capital of 600,000 florins and be styled "The Farmers' Vend Trust Company."—(*The Chamber of Commerce Journal*, Vol. LVI, No. 755.)

Peru.

The Agricultural Industry in Peru is almost exclusively in native hands and while it employs the largest number of people of any industry in the country it also represents the largest national investment. Of the three million acres of land under cultivation one million are along the coastal zone and the remainder in the Andean and Trans-Andean region. Agricultural investments amount to £p.63,000,000. This excludes the value of livestock of which 60 per cent. has been placed in the irrigated districts of the coast. The principal products in order of importance are cotton, sugar, wheat, rice, potatoes, maize, barley, alfalfa, tobacco, coffee, and cocoa, in addition to fruits of all kinds, such as bananas, oranges, grapes, olives, alligator pears, custard apples and mangoes. Most of the capital of the country has been invested in cotton and sugar at the expense of market gardening and the growing of other crops, with the result that food has to be imported and is always scarce and very costly in the large consuming centres A policy of more mixed farming, greater rotation of crops and less concentration on specialised products, together with the introduction of more efficient methods of cultivation, has been urged to remedy the present state of agriculture in Peru. —(*Jr. Royal Society of Arts*, Vol. LXXVI, No. 3941.)

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Nyasaland.

The following figures for the year 1927 were supplied through the courtesy of the Nyasaland Director of Agriculture, and indicate the acreage and chief agricultural products grown in the Protectorate :—

CROP.	Acreage.	Gross quantity of produce (for local consumption and export).
1. *European Agriculture.*		Cwts.
* Tobacco	25,002	93,647
* Tea	7,070	11,031
* Fibres	6,282	20,743
Maize	4,699	46,956
* Cotton (lint)	2,545	1,648
Beans	1,601	5,949
* Rubber	1,320	1,599
* Coffee	1,239	574
2. *Native Agriculture.*		Tons.
* Tobacco	....	3,484
* Cotton (seed cotton)	....	1,387

* Chillies, * capsicums, millet, wheat, groundnuts, are also grown but only in small quantities. Livestock is chiefly represented by: Goats (198,508), horned cattle (138,434), sheep (100,235), and pigs (55,833).

* Grown primarily for export.

REVIEWS.

AGRICULTURE.

THE ELEMENTS OF LIVE STOCK JUDGING. By William W. Smith, M.S.A., J. B. Lippincott Company, London, 147 pages, 82 illustrations.

The ordinary system of card scoring has been adopted and the values attributed to the different points are fair and reasonable and call for no criticism. An admirable feature is the stress laid on utility points rather than on fancy points throughout the book. However, the chief value of the book lies in the manner in which very full and definite reasons for the practical utility of each point are given, enabling the uninformed reader to take a live interest in, and to realise at once the precise value of live stock judging. The photographs and diagrams are all excellent and are really helpful in attempting to give an insight into a subject which can only be taught efficiently in the presence of live stock itself. A valuable book.

A. L. B.

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AGRICULTURAL GEOLOGY. John E. Marr. Second Edition. Methuen & Co., Price 7*s*. 6*d*. pp. xi + 318.

This is a reprint, apparently without any modification, of a book which originally appeared in 1902. It was intended, definitely, as a text-book for the use of Agricultural Students, and, as was to be expected from such an able lecturer as Professor Marr, was a clear and lucid exposition of the subject. It has been a familiar textbook to many generations of Agricultural Students, and will doubtless remain in favour for many years yet.

R. C. W.

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BOTANY.

AN INTRODUCTION TO THE STUDY OF PLANTS. By F. E. Fritsch, and E. J. Salisbury. 2nd Edition. Reprinted 1925, London. G. Bell and Sons.

The popularity of this book may be judged by the fact that six reprints have appeared in the comparatively short space of time that has elapsed since the publication of the second edition in 1917. It is in fact rapidly becoming a standard text-book in England.

Roughly speaking the ground covered is that laid down in the regulations for the London Matriculation, but the arbitrary boundaries of the Examination Syllabus have nowhere been adhered to, where these would be prejudicial to the logical presentation of the subject matter. Whilst the book is of much value to students preparing for the London Matriculation, it will also appeal, by reason of its scope and pleasing style, to a much larger body of students who, having no particular examination in view wish to obtain a thorough grounding in Botany.

The first eight chapters are mainly concerned with the morphology of plant organs, not omitting to stress the correlation between form of function. Chapter four is introductory to the study of soils. Chapters nine to seventeen deal with the outstanding physiological aspects of plant life, water supply, nutrition, food storage, respiration, growth, and irritability.

The sexual reproduction of plants is described in chapters eighteen to twenty-one. Special reference is made to peculiar mechanisms of flowers adapting them to the visits of pollinating insects. Chapter twenty-two deals with the formation of seeds and fruits and their dispersal. Of the remaining chapters, numbers twenty-three to twenty-seven will naturally be of least use to the student in the Tropics. Chapter twenty-three deals with some of the commoner plant families in Britain, a number of these are but poorly represented in the Tropics. The other four chapters are concerned with the ecology of woodland, heath, marsh, and sea shore plant communities as they exist in Britain. There is a short chapter, twenty-eight, which serves as an introduction to the different types of plant life, further described in the companion volume, "An Introduction to the Structure and Reproduction of Plants."

Finally there is a useful appendix with notes on experimental procedure, and the making up of re-agents.

R. E. H.

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A MANUAL OF PLANT BREEDING FOR THE TROPICS. By Nemesio Blanco Mendiola, Manila Bureau of Printing 1926.

This book presents the plant-breeder in the Tropics with a review of the known characteristics of a number of plants of agricultural and horticultural interest together with suggestions relating to their improvement.

The subject matter is based mainly on the results obtained at the College of Agriculture, Los Banos, and the crop plants which receive most attention are those which are of importance in the Philippines; Cotton and Cacao, to mention two, are dismissed with a few paragraphs only.

It is stated in the preface that the book is mainly intended for the use of students who have already received a grounding in Genetics; familiarity with Mendelian phenomena is therefore assumed. Bearing this in mind the chapter on "Important Genetic Facts," which is written in popular style, might have been omitted as the treatment is quite inadequate for readers ignorant of genetical phenomena.

Popularisms are always out of place in a technical work and it seems rather unfortunate that, in a book on plant breeding, the author should repeatedly speak of good or bad "blood" when

referring to genes bearing desirable or undesirable characters. The general style is rather verbose but literary presentation apart, there will be found much useful information on the practical conduct of plant breeding operations, and on the variability of the crop material. There are useful notes on the errors likely to appear when making comparative variety yield trials. The book will take its place in helping to fill the big gap in authoritative publications on tropical crop-plants.

R. E. H.

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AN INTRODUCTION TO THE STRUCTURE AND REPRODUCTION OF PLANTS. By F. E. Fritsch and E. J. Salisbury. 2nd Edition, 1927. London. G. Bell and Sons.

This volume forms, as is stated in the authors' preface, a sequel to the Introduction to the Study of Plants and carries the student up to, and in many ways, beyond the standard of the London Intermediate and Higher School Examinations. Like its forerunner it was not specially written with an examination syllabus in view, and is in consequence of much greater interest and utility than are a large number of text-books.

The book is divided into two parts. Part I, the Anatomy and Histology of plants and Part II, their Life Histories and Reproduction.

Chapters one to five deal with the histological structure of the plant cell and its physiology; reproduction (cell division), growth, and cell contents. The Anatomy and Histology of the root, stem, and leaves, and the structure of special tissues is described in chapters six to thirteen.

The life histories and reproduction of the different forms of plant life are arranged in sequence beginning with the lowly forms and leading up to the most highly evolved. Chapters fourteen to twenty-four deal in turn with the Algae and Fungi; Liverworts and Mosses; Ferns, Horsetails and Club Mosses; Cycads; Conifers; and finally with the Flowering Plants.

An introduction to study of heredital phenomena, and to problems of evolution is given in chapter twenty-five. There is a useful appendix containing notes on practical technique and also a bibliography.

R. E. H.

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THE FAMILIES OF FLOWERING PLANTS—I. DICOTYLEDONS. By J. Hutchinson. London, Macmillan & Co., 1926.

In this volume, Mr. Hutchinson has presented us with a re-arrangement of the families included in the Dicotyledons based upon the most recent ideas of natural phylogeny.

In any flora the arrangement cannot fail to be to a certain extent arbitrary since a flora is really a convenient form of catalogue of the living plants. Owing to the imperfections of the fossil record we do not know all the intermediate evolutionary forms which have led up to the existing plants; consequently in arranging a flora there are considerable difficulties in arriving at a system which will successfully indicate the natural relationships of the plants. The ultimate details will always depend largely upon personal judgment.

The present system is intended to replace that of Engler and Prantl, which also claimed to be a natural classification but which has, of recent years, found less favour among students of taxonomy as precise information has accumulated.

Mr. Hutchinson regards the Ranalian complex as the most primitive and distinguishes two main lines of descent from this complex. Those with a predominant tendency to an arboreal habit, and those with an herbaceous habit.

He has also constructed a very complete artificial key to the families. Clear illustrations are given of a typical representative from each family. The flora cannot fail to be of interest to the student of taxonomy. Time and experience alone will show if it possesses marked advantages in use over previous classifications.

R. E. H.

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MYCOLOGY.

INSECT AND FUNGUS PESTS OF THE FARM. By J. C. Fryer, M.A. and F. T. Brooks, M.A. Ernest Benn, Ltd., London, 1928.

This little manual, divided almost equally into a general discussion of the conditions of health and disease in crops and a detailed account of some specific cases, is written by two well known authorities and is admirably suited to its purpose. That purpose, however, is the education of the English farmer, and even the general section is so coloured by English examples that the book cannot be said to have any wide sphere of usefulness outside the United Kingdom.

E. E. C.

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CHEMISTRY.

COLLOID SYMPOSIUM MONOGRAPH V.—(Papers presented at the Fifth National Symposium of Colloid Chemistry, University of Michigan, June, 1927.) Edited by H. B. Weiser. Published by the Chemical Catalog Co., New York, 1928. Price $6.50.

This collection of papers by different authorities (not by one, as the title would imply) is the fifth of a series of annual volumes that has done much to keep the student informed of the rapid progress which Colloid Science has made during the past few years. The papers deal both with general problems and with the application of theories to various processes, such as the action of the kidney, the electro-deposition of metals, the formation of soap gels, the moulding of metals in sand, the hardening of cement, and the resistance

of insects to cold. In all there are twenty-four papers. The keynote to the rôle which Colloid Science is playing in the gradual clearing up of a great mass of hitherto inexplicable facts, is given by the title of the first paper "Unity in the Theory of Colloids" by Dr. H. R. Kruyt, of the University of Utrecht, guest of honour at the Michigan Meeting.

F. H.

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PRACTICAL PHYSICAL CHEMISTRY. By Alexander Findlay, M.A., D.SC., Fourth Edition, New Impression. Longmans, Green & Co., Ltd., London, 1928. 7*s*. 6*d*. nett pp. 298.

This is a standard text-book in most British Universities and cannot be too highly commended as a "guide to the more fundamental practical methods and experimental foundations of Physical Chemistry." To the modern sugar chemist it is of particular value, dealing in detail with such measurements as viscosity, surface tension, refractive index, electrical conductivity, electromotive force and hydrogen-ion concentration.

A welcome addition is a chapter dealing with some of the more prominent properties associated with the colloidal state.

The general arrangement and printing of the book leave nothing to be desired.

R. H. H.

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THE PHASE RULE AND ITS APPLICATIONS. By Alexander Findlay, M.A., D.SC., F.I.C. Longmans, Green & Co., Ltd., London, 1927. 10*s*. 6*d*. nett, pp. 326.

This is a sixth and revised edition of a work which is probably the best of its kind published. The author has achieved his object of presenting and explaining the principles underlying the Phase Rule in non-mathematical language.

The study of chemical equilibria finds application in almost every field of chemical industry. To the Sugar Research Chemist who is seeking knowledge of the constitution of molasses it is indispensable.

This book is one of a series of "Text-Books on Physical Chemistry" edited by Sir William Ramsay and Professor F. G. Doonan, which has earned a very wide reputation.

R. H. H.

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BIOCHEMICAL LABORATORY METHODS. By Clarence Austin Morrow, PH.D. John Wiley & Sons, Inc., New York; Chapman & Hall, London, 1927. pp. 350.

This is a well written book covering every phase of practical biophysics and biochemistry. The experiments have been carefully selected and the methods explained in sufficiently great detail to be followed by biological students who have not had special training in chemistry.

An excellent feature is the wealth of references given after each experiment.

The book is a very welcome addition to the literature on this subject.

R. H. H.

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ECONOMICS.

SCIENTIFIC MANAGEMENT IN EUROPE, Paul Devinat, G. S. King & Sons. pp. xii + 260. Price 4*s*.

Scientific management studies the relations between the different factors of production and especially those between human and mechanical factors, with the object of obtaining by rational utilisation, the most economical production. The results obtained from industrial technique, psychology, physiology, and economics are used, and on the basis of numerous daily observations methods of improvement are devised and advocated. By means of a fuller knowledge of the factors of production, its aim is gradually to replace industrial empiricism by increasingly exact rules. In its early stages scientific management was limited to technique in industrial production-workshop planning, choice and layout of equipment and raw materials, &c. Later it branched into psycho-physiology; by vocational selection, fatigue and motion study, improving individual effort, and by the study of wage payment and industrial relations improving collective effort. Mr. Devinat, gives an enthusiastic survey of the growth and progress of the movement, practical applications and opinions. Scientific management or management based on records, &c. instead of on individual genius has progressed farthest in industry but the agricultural applications are not being overlooked. Among the institutions propagating its utilisation in agriculture, are the following:—*France:* Commission d'étude de la Confederation nationale des associations agricoles. *Germany:* A committee on 'Arbeitsgemeinschaft Technik in der Landwirtschaft' publishes a review, and a series of propaganda pamphlets, graphs and posters which explain the proper use of agricultural machinery and technical appliances. *Russia:* Station of normalisation experiments in agricultural labour. *Czechoslavakia:* The Masaryk Academy of Labour has a section on agriculture and sylviculture dealing with the scientific organisation of labour and the unification and standardisation of agricultural produce. In *England* the National Institute of Industrial Psychology recently supervised and partly financed "An investigation of certain processes and conditions on farms" which is reviewed below.

G. W.

AN INVESTIGATION OF CERTAIN PROCESSES AND CONDITIONS OF FARMS. W. R. Dunlop. National Institute of Industrial Psychology, London. pp. 71. Price 2s.

The report describes the first applications of the methods of industrial psychology to agriculture and horticulture in England. Two investigations are made (1) the picking and packing of fruit, (2) milking. Time taken to perform work under the old methods is recorded and on the basis of observation new methods are suggested for time saving—of interest to the employer—and fatigue reduction—of value to the worker. The suggestions made are interesting, but the reader must be referred to the publication for details. With regard to milking it is stated that the rate of milking could be increased by the elimination of hard cows, holders and kickers; by the training of workers; by reduction of flies and improvement of ventilation and lighting. An adjustable stool would be more useful than the ordinary milking stool on account of the variable height of the teats from the ground. In a foreword, Dr. Myers, Director of the National Institute of Industrial Psychology—under the auspices of which the report is published—states "The appearance of the report will be justified if it indicates the vast improvements in efficiency and contentment, which may be expected from a systematic study of the workers movement in production time, arrangement of material, methods of payment, general layout, suitability of tools and the selection of the workers according to his special abilities for the work he has to undertake.

G. W.

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THE MARKETING OF FARM PRODUCTS. By L. D. H. Weld, PH. D. Macmillan Co., New York, Pages xiv+483, Price 12s.

MARKETING, ITS PROBLEM AND METHODS. By C. S. Duncan, PH.D. Appleton & Co. Pages xiv+500.

Mr. Weld sets out to describe the mechanism of marketing and succeeds. The book was first published in 1916 and although changes have undoubtedly taken place, it does not appear to have been revised. Mr. Duncan's book is divided into two parts—Raw materials and food stuffs: Manufactured Products. Agriculturists will be concerned mainly with the first part, which gives suggestive methods for commodity and market analysis, following this up with chapters on trade organisation, the middleman, transportation, exchanges, grading, finance, &c. The method of attack and the presentation of the subject is attractive.

G. W.

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MEMORANDUM ON LABOUR CONDITIONS IN CHINA. Cmd. 2846. His Majesty's Stationery Office.

Industrialisation has just begun in China and the labour conditions correspond to those in England at a similar stage of development. The Chinese workers seem as apathetic to their lot as did the English. "The perfectly appalling conditions that exist have apparently up to now raised no great indignation in the breasts of the Chinese workers. In fact, so far as consular opinion goes, the Chinese worker is said to be comparatively content with his lot, and considers himself fortunate if he has constant employment." Clearly, agitation for reform must come from outside. A movement has now been started, said to be initiated by factory owners, missionaries and women societies, to promise some improvement in the conditions of labour and to draw attention to such questions as hours of labour, prevention of accidents, hygiene, child labour, &c.

G. W.

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MINIMUM WAGE-FIXING MACHINERY. An International Study of Legislation and Practice. International Labour Office. P. S. King & Sons, Ltd. London, S.W.1. Price 2s. 6d. (60 cents). Pages 6-155.

Part I contains an analytical study of the objects, machinery and basis of minimum wage legislation. Part II gives a description, country by country, of the legislation in force. Although some attention has been given to the matter in the tropics—*e.g.* Trinidad—the report does not deal with these cases. Within its limits it is a valuable publication, the tabular summary of minimum wage systems of various countries being particularly useful.

G. W.

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INTERNATIONAL YEARBOOK OF AGRICULTURAL LEGISLATION, XVITH YEAR, 1926. Printing Office of the International Institute of Agriculture, Rome.

This is the 1926 edition of a well-known reference book invaluable to those interested in agriculture and the trade in agricultural products. The Yearbook is divided into three sections. The first consists of the texts of laws grouped according to subject matter; the second contains titles and sources only, arranged in chronological index according to countries, this section serving further as a chronological index according to countries, the third section is an alphabetical index.

G. W.

* * *

RESULTS OF CERTAIN OF THE ENQUIRIES FOR INSTITUTING A COMPARISON BETWEEN THE RETAIL PRICES IN PRIVATE TRADE AND THOSE OF DISTRIBUTIVE CO-OPERATIVE SOCIETIES. League of Nations, Geneva. Price 1s. 3d. pp. 31.

Although the comparisons in this study are limited to prices actually charged, it is shown in general the prices charged by the Distributive Co-operative Societies are lower than those of private enterprises. Of course they would be lower still if corrected by the amount of the dividend distributed at the end of the financial year.

G. W.

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

Effect of Fertilisers on Cotton Yields.

A study of the influence of various fertilisers on cotton yields show that the yield may be increased by the influence of the fertilisers on at least three distinct factors. Firstly, the fertiliser may increase the number of bolls per acre without affecting the average size of the individual cotton bolls. Secondly, the size of the bolls and the number of bolls per acre may be increased. Thirdly, the size of the bolls and the percentage of lint per boll may be increased. Assuming the quality of the fibre to remain constant, the last method of increasing the yield should be the most profitable.

Addition of a nitrogen-phosphate fertiliser increased the total yield of cotton by 20 per cent. There was an increase of 22.6 per cent. in the number of bolls per acre. The bolls were slightly less in size than those on the control plot, and the percentage of lint per boll increased only slightly. The increased yield was therefore entirely due to the increase in the number of bolls per acre. Fertilising with phosphate and potassium gave an increase of 10 per cent. in the total yield. The number of bolls per acre, however, had decreased, and the increased yield was due to a 13 per cent. increase in the size of the bolls and a 5.3 per cent. increase in the percentage of lint. Nitrogen-potassium treatment increased the number of bolls only by a small amount. The great increase in total yield was accounted for by a large increase in the size of the bolls and in the percentage of lint per boll. The last applications therefore gave the most satisfactory results.—(*Journal of Amer. Soc. Agron.* 20, 1048.)

* * *

The Optimum Soil Reaction for the Tea Plant.

The tea plant is one of the few plants which appear to have best development in a strongly acid soil. Experiments to illustrate and confirm this have been conducted by C. H. Gadd (*Tea Quarterly*, Vol. I, pp. 2 and 31). Tea seedlings were grown in standard culture solutions for a period of six weeks. The well-developed plants were then transferred into solutions of similar composition but with pH values adjusted to values between 3.5 and 7.5. In the more acid solutions, some of the nutrients were precipitated and their concentrations thus lowered. A tendency for the pH values of the solutions to change owing to their low buffer capacity was checked by the frequent addition of the requisite amount of acid or alkali. At intervals of three weeks, the plants were weighed and placed in fresh, similar solutions. After nine weeks the plants were transferred to filtered tap water and allowed to grow for four weeks. The plants were then replaced in nutrient solution but the order of the plants was reversed, those previously in a solution of low pH value being now placed in a solution of high pH value. The plants were again weighed at intervals.

The highest percentage increase in weight was made by those plants growing in a solution of pH value 3.5, both during the first period and during the second. Those growing in the more alkaline solutions produced smaller leaves which showed chlorosis. Those growing in acid media produced large, healthy leaves, but not necessarily in larger numbers. Again, in acid solutions the roots were white and healthy and new ones were produced, while the roots in the more alkaline solutions turned brown and no new ones were formed. In the second period when the brown roots were placed in acid solution, new roots developed immediately and those already present appeared white and healthy.

These experiments show that under culture solution conditions, the optimum pH reaction for the tea plant is 3.5. It is to be hoped that the experiments will be continued by growing plants under more natural conditions in soils of different reactions.

* * *

The Effect of Heat on Cotton.

Cotton plays an important part in the construction of many rubber goods, and the properties of such articles as pneumatic tyres are largely influenced by the properties of the cotton fibre they contain. Heat is known to affect the properties of cotton fibre. Thus, when heated for twelve hours at 70°C., it loses tensile strength and becomes brittle and less elastic. It will, however, on exposure to moisture and air regain its normal properties. Heating in the presence of traces of strong acids causes decomposition of the cellulose. The manufacturing process of rubber material containing cotton includes vulcanization, which necessitates strong heating. The addition of sulphur and other chemicals to the rubber may produce traces of strong acids. It will be seen therefore that although the initial fabric may be of suitable strength and elasticity, the severe treatment it undergoes may change both its physical and chemical properties.

A study of cotton fibre from this point of view showed that heating to above 120°C. caused a permanent loss of strength, and at 240°C. almost total decomposition occurred. The detrimental effect of the heating is due partly to the action of oxygen, and the loss of strength is reduced by the exclusion of air. Application of heat alone appears to affect only the breaking point and not the elasticity of the fibre.

An understanding of these changes should enable manufacturers to select fibres with the highest resistant power to the influences of the vulcanization treatment and a better final article should result.—(*A. H. Tiltman and B. D. Porritt, India-Rubber Journal*, Vol. 76, No. 7, p. 9.)

TRINIDAD COTTON RESEARCH STATION.

Experimental Greenhouse.

Tucker, Picture Co.

TRINIDAD COTTON RESEARCH STATION.

Photograph by *Tucker Picture Co.*

American Upland Cotton

Photograph by *Tucker Picture Co.*

Contouring ridges with Hand Cultivator

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

The real acidity in sugar manufacture, its determination with indicators, and its effect on the product.

P. Honig, Arch. Suikerind. 36, 212-22 (1928), points out the advantages of pH determination over the titrimetic method and explains why the drop method is preferable. During the crop of 1927 several difficulties appeared. The indicators used were bromothymol blue (BTB) and p—*a*—naphthol (PAN). It happened sometimes that in turbid juices the pH with one indicator was higher than with the other. In juices clarified by the sulphitation process the pH with PAN was higher than with BTB. After filtration of these juices with kieselguhr or norit the BTB pH showed only a very small change, but the PAN pH gave too high results. Different explanations of this fact are discussed. The influence of the temperature on the pH will have to be studied. Juices entering the evaporators neutral in several instances yielded return waters decidedly alkaline, while juices which were certainly not over sulphitated gave return water containing SO_2. This shows that the juices contain substances which at high temperature have a tendency to lower the pH. The influence of the concentration of the juices is another point to be studied. The pH of syrups and molasses was determined at different concentrations, but definite conclusions are not possible so far. There are indications that the unknown losses are greatly reduced by working throughout the process at pH 7, measured at low temperature and without dilution. The colloids are affected not only by the H ions but by other ions also. Several non-sugars go again into true solution with a slightly acid or slightly alkaline reaction, and even if they are not entirely precipitated during clarification, their bad effect on crystallisation is lessened. The influence of the Ca ion on clarification and crystallisation is of great importance and will have to be studied; also the influence of the anions on colloids. The coagulating effect of the anion is of quite as great importance as that of H ion.—(*Chem. Abstracts*, 1928.)

* * *

Study of the speed of solution of sugar.

K. Sandera (Z. Zuckerind. Cechoslov. Rep. 52, 154-60 (1927)), determined first the speed of solution of single crystals and of pellets of amorphous sugar. He placed a weighed crystal, or pellet, on a fine copper screen which was then submerged below the surface of still H_2O of 20°. The time necessary for complete solution was measured. On crystals, probably on account of their anisotropy, speed of solution varied somewhat because of different speeds of solution in their diverse directions. Pellets, however, being isotropic, gave closely agreeing results. The speed of solution, expressed in g. per sec. per sq.cm., is a const., $K=1{\cdot}6\times10^{-4}$, and is approx. the same for sugars of different shape and kind. It is a function of structure and surface. In another series of experiments S. determined the speed of solution of white sugar crystals of different size during washing. He placed on a screen with glass bottom 10 g. of crystals, over which 100 cc. of H_2O of 20° was permitted to flow; within one minute the wash liquid was polarized. The crystals of different size showed the following percentage of solubility: coarse 11.8, medium 27.6, fine 59.0, flour 86.0. This shows, in conformance with previous determinations and the experience of practice, that a given quantity of H_2O will dissolve, in the same time, the more sucrose the finer and more uneven is the grain, or the larger the surface of the grain. Similar experiments were made with raw sugars, in which, besides degree of solubility, it is also of interest to know what amount of impurities a given quantity of H_2O will remove in a given time. Great differences in solubility and removal of non-sugars were found to exist in raw sugars of different grain, size and quality.—(*Chemical Abstracts*, 1928.)

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H.I.C. Indicators in White Sugar manufacture.

The application of pH measurements to plantation white sugar manufacture is discussed by R. G. Padhye (Trans. Soc. Sugar-Cane Technologists, Cuba, 1927.)

Mixed juice is sulphured to about 2.8 to 3.0 c.c. of N/10 NaOH per 10 c.c., using phenolphthalein, treated with lime cream of 12° Be., and sent to eliminators, where it is "cracked" and settled. On introducing pH control, it was found that the best clarified juices had a pH of 6.8, though their acidities to phenolphthalein varied quite considerably. This is the buffer effect of the calcium sulphite preventing the dissociation of the acid. Optimum results are obtained by working to a fixed pH, the variable acidity found by titration not being considered. — (*I.S.J.*, No. 358, Vol. XXX, p. 559.)

* * *

Simultaneous adsorption of sucrose and colouring matter by adsorption of carbons.

J. Vasátko. (Z. Zukerind. Checoslovak. Rep. 52, 45-52, 1927.) states that the presence of sucrose reduces the decolourizing power of the char. Increased sucrose adsorption is accompanied by increased ability of the carbon to adsorb more H_2O. Adsorption of colouring matter is irreversible and grows with increasing temp. Concd. sugar soln. is a poor medium to accomplish chem. or chem. phys. reactions. All purification processes occur more rapidly and the more completely the more dil. the solns. are or the less sucrose they contain. Therefore, decolourization of sugar soln. is best and most economically carried out in thin juices. The rate of adsorption of colouring matter is greatest in the first 5 min. and improves with increasing temp. Alky. falls with length of time of contact and increased temp.—(*Chemical Abstracts*, 1928.)

COLLEGE NEWS.

Dr. C. W. Wardlaw, Pathologist to the College Banana Research Station, returned from Central America by s.s. *Simon Bolivar* on 21st October.

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Dr. Laurence P. McGuire, Plant Physiologist for Banana Research under the Empire Marketing Board sailed for Central America by s.s. *Cavina* on 20th October.

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Mr. H. A. Ballou, Professor of Zoology and Entomology and Commissioner of Agriculture for the West Indies, returned from the Leeward and Windward Islands by s.s. *Canadian Skirmisher* on 19th October.

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Mr. A. H. Lewis, B.Sc., Hon. Chem. (Lond.) who was awarded his Associateship at the last College session has been appointed a Research Chemist to Nitram Ltd., a company closely associated with "Imperial Chemical Industries."

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Our thanks are due to Mr. J. Connell, Director of Messrs. Law and Connell, Engineers, Barbados, for presenting the College with a gauge for mill setting, of his own design, which is more convenient and accurate than the old method of making settings.

* * *

Recent visitors to the College include Mrs. Florence Davies, Natal; K. A. Campbell, Scotland; J. du Boulay, Chas. J. Devaux, and F. Stewart, St. Lucia; J. C. Macintyre, Dominica; J. J. Montealegre, Costa Rica and W. P. Scott of Messrs. Lever Bros., Ltd.

* * *

We are greatly indebted to Dr. K. S. Wise, Surgeon-General, for the loan of some very instructive films on the mosquito and the fly which were exhibited at the College by Mr. L. Tucker on 23rd October. These films were produced for the Public Health Department by the Tucker Picture Co. and the British Instructional Films, Ltd. Another film, entitled "Safety First, travel by train" was also shown. The programme was much enjoyed by all those present and the Principal thanked Mr. Tucker on behalf of the College, for the excellent entertainment that had been provided.

* * *

The first meeting of the Trinidad Science Club was held on 25th October when Dr. Thomas W. M. Cameron, M.A., D.Sc., M.R.C.V.S., Lecturer in Helminthology and Assistant Director of Parasitology at the London School of Tropical Medicine, gave an address on "The Importance of Parasitology in the Tropics." Dr. Cameron has recently been conducting research work in St. Kitts and St. Lucia where *bilharzia*, a blood parasite, has been found in certain districts to infect a percentage of the population. In Trinidad he has investigated the presence of hook-worm in pigs. The second meeting of the Club was held on 8th November, when The Hon. W. G. Freeman, B.Sc., A.R.C.S., F.L.S., Director of Agriculture, Trinidad and Tobago, lectured on "The Cocoa Industry of Trinidad and measures for its improvement."

* * *

Mr. Eric Macfadyen and Mr. Cecil Hanbury have been co-opted as Governors of the College. Mr. Macfadyen has long been associated with the Federated Malay States, and was formerly a Member of Council of that Government and Chairman of the Planters' Association. He is a Director of Harrisons & Crosfields, Ltd., and of various rubber and tea companies. Mr. Hanbury is M.P. for North Dorset. He has travelled extensively in the far East and the Colonies and was formerly a partner in Ward, Hanbury & Co., China merchants of London and Shanghai.

* * *

Examination Results.

At a meeting of the Academic Board held on 16th October the following students were awarded the Associateship of the Imperial College of Tropical Agriculture: J. E. Bruce (Dip. Agric., Glasgow), A. H. Savile (Dip. Agric., Wye), H. A. Pieris, B.A. (Cantab.)

Appointments.

The following appointments of students in residence at the College during the Session 1927-28 have been notified by the Secretary of State for the Colonies.

Mr. J. D. Broatch, B.Sc. (Agric.), Assistant Superintendent, Agricultural Department, Gold Coast.

Mr. C. L. Skidmore, B.Sc. (Agric.), Assistant Superintendent of Agriculture, Gold Coast.

Mr. J. E. Bruce, N.D.D., N.D.A., District Agricultural Officer, Tanganyika Territory.

* * *

Miss E. B. Robinson's Retirement.

MISS ROBINSON, the senior typist and stenographer at the College, is shortly retiring, after 30 years service. She entered the Imperial Department of Agriculture for the West Indies at its inception on the 15th October, 1898, and served continuously during its existence. On 31st March, 1922, the old Department became merged into the Imperial College of Tropical Agriculture, and Miss Robinson was absorbed into the staff of the new Institution.

During the first few years after the opening of the College, until the Hostel was completed, she rendered material assistance by undertaking the boarding of some of the overseas students.

The Principal presided over a gathering of the staff and members of the College at the College on Saturday morning, the 10th November, when the opportunity was taken to ask Lady Watts to present her with a silver mesh purse and cheque, as a visible token of the esteem in which she is held by her colleagues. Sir Francis Watts voiced the feelings of those present when he wished her all good fortune and the best of health during her retirement.

AGRICULTURAL EXCURSIONS.

In connection with the training of Post-Graduate students at the College, a series of field days has been organised, and these excursions are so arranged that the subjects, or crops dealt with, coincide, as far as possible, with the current courses of lectures.

At the beginning of the Session subjects of general interest to the potential tropical agriculturist are dealt with. The first excursion consisted of a visit to the St. Augustine Experimental Farm on Wednesday, 10th October, where students, new to the tropics, had the opportunity of seeing a wide range of typical crops growing on a field scale. The party was escorted round by the Farm Manager, Mr. L. Brunton, whose explanations were much appreciated.

On the 17th October a visit was paid to the Government Stock Farm, at St. Joseph, where various breeds of stock used in the tropics were inspected. Attention was paid, in particular, to the care and management of draught cattle and mules. Feeding stuffs were discussed and various kinds of fodder grasses and crops were inspected in the field. Tropical dairying will form the occasion of another visit to the Stock Farm later on in the Session. Captain H. V. M. Metivier and his staff were good enough to conduct the party round the stalls and through the paddocks, and a most instructive morning was spent.

Those who attended both these excursions are very much indebted for the hospitality which was so freely extended to them.

The excursion of 24th October was organised with the object of demonstrating practical measures of controlling malaria under estate conditions. The excursion was in charge of Dr. E. A. Seagar, the Professor of Hygiene, assisted by Mr. F. W. Urich and other members of the Staff and two Sanitary Inspectors, whose services were kindly lent for the occasion by the Public Health Department of the Trinidad Government. Different species of mosquitoes were identified and their breeding places pointed out. Methods of control by clearing out ditches and drains, spraying with oil, and other practical measures, were demonstrated, the whole idea being to indicate what general measures are feasible under ordinary living conditions in the tropics.

On 31st October a visit was made to Woodford Lodge Sugar Estate, where a considerable area of cane was found to be badly blighted by the Froghopper (*Tomaspis*), nymphs in all stages and adults being abundant. The history of the Froghopper Investigation Committee, appointed by the Trinidad Government to devise means of control, was explained by Professor Hardy.

It is, perhaps, needless to remark, that the College is very deeply interested in this investigation. Starting first of all as an entomological problem, its sphere of action became wider and wider as investigation proceeded, and it thus forms an excellent example of the immense scope for research that is so often afforded by certain classes of pests. In this instance a useful direct control has been found by dusting the first brood each year with cyanogas—(first introduced into Trinidad by Mr. Urich), but the fundamental principle underlying the fact that certain areas suffer more from blighting, with a similar degree of froghopper infestation, than others, are now being examined, and considerable light has already been thrown on these problems. A definite correlation between the lime status of the soil and the degree of actual blighting has been established, and these points were brought out by Professor Hardy during the course of his field lecture.

On the return journey a visit was made to a portion of Caroni Estate, where the control advocated of thoroughly dusting the first brood with cyanogas, has this year proved singularly successful in controlling the blight. This estate has adopted also a definite liming programme, and Mr. L. Grant, the Manager, who was good enough to explain the situation, appears to be convinced that the advice given in this respect is thoroughly sound.

G. E.

SPORTS.

Three rugby, two association and two hockey matches have been played up to date with the following results :—

		Rugby Football Club :		
Oct. 18th	*v.*	Trinidad Northern R.F.C.	Won	10 - 3
Oct. 21st	*v.*	Southern R.F.C.	Won	14 - 6
Oct. 30th	*v.*	Demerara R.F.C.	Won	5 - 3
		Association Football Club :		
Oct. 16th	*v.*	Constabulary A.F.C.	Won	1 - 0
Nov. 2nd	*v.*	Sporting Club A.F.C.	Drawn	0 - 0
		Hockey Club :		
Nov. 3rd	*v.*	Constabulary H.C.	Lost	1 - 3
Nov. 5th	*v.*	Wanderers' H. C.	Lost	1 - 2

As will be seen from these results, this year's prospects are decidedly encouraging. The rugby match with Demerara was contested in Port-of-Spain on a very muddy ground and provided a very keen struggle. The College forwards, starting with a great rush, carried the ball down to their opponents' twenty-five where they remained for the first fifteen minutes of the game and where Barnard scored the one and only College try, by slipping through the defence from a scrum near the Demerara goal line. Wright converted. The rest of the game was a battle in the mud, the College XV having their defence severely tested by repeated attacks from the visiting team's three-quarters, one of whom eventually got through and scored. Although Demerara had the better of the game during the second half, the College eventually won after an excellent match.

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR.—Recent prices have ranged as follows: Foreign, c.i.f., per cwt., 10*s.* 1½*d.* (10th Oct.), 10*s.* 3*d.* (22nd Oct.), 10*s.* (31st Oct.), 9*s.* 7½*d.* (6th Nov.), preferential, c.i.f. per cwt., 13*s.* 10½*d.* (10th Oct.), 14*s.* (22nd Oct.), 13*s.* 9*d.* (31st Oct.), 13*s.* 4½*d.* (6th Nov.). Java continued to attract a good deal of attention in Sugar circles, and additional important sales made by the United Java Sugar Producers' Association of Whites and Browns with Western options provided the only important feature in an otherwise uninteresting market. Up to 30th September, U.K. imports were 28,779,665 cwt. against 24,760,408 cwt. last year, and yet only 2,919,000 cwt. were in bond, against 5,184,000 cwt. in October last year. This evidence of vigorous business is some consolation to the market for the low prices prevailing.

* * *

COCOA.—6th November.—In New York the outstanding development has been the Bahia valorization scheme whereby the Government will advance money at 7 per cent. to certain cocoa merchants to enable the purchase of cocoa in an endeavour to stabilize the price at around 11 cents cost and freight New York. It is believed that any loss on purchases will be borne in the ratio of 70 per cent. by the Government and 30 per cent. by the buyers and ultimately collected through adjustment of export tax. This scheme has had no apparent effect on the market as business generally has been dull and likely to remain so until after the Presidential Elections. London on the other hand is rather easier on the dissolving of the Accra selling group, and now that this crop is in full swing the future of the market will depend on the size and disposal thereof. (*By courtesy of the Cocoa Planters' Association, Trinidad.*) Latest local quotations are, Trinidad L.L.T. 61-67*s.* per cwt., Grenada L.L.T. 52-60*s.* per cwt.

* * *

COTTON.—The tendency at the end of October was towards higher levels. Probably the strongest constructive factor in the market is the steady expansion and belief in further trade improvement all over the world. On 18th October, Mid-American stood at 11.09*d.* per lb. Fair business was done in African, and East Indian continued in good demand. Sea Island was in limited request. The Egyptian market was fairly steady and a fair business on the spot in uppers. Since our last issue the Annual Circular of the Liverpool Cotton Association has been published, and from this the following table of imports into Great Britain, 1927-28, is compiled:—

Descriptions.	*lb.*
American	717,706,767
Brazilian, &c. ..	30,837,690
Peruvian, &c. ..	88,433,632
Egyptian	270,533,025
Sudan	48,909,600
West Indian, &c. ..	3,848,912
East African, &c. ..	31,098,480
West African ..	10,417,410
Australian	667,079
East Indian, &c. ..	88,131,420

* * *

COFFEE.—In mid October quiet conditions were prevailing in the market. The attention of buyers being concentrated principally on new crop Kenyas, Continential markets were also depressed. It is stated that hand to mouth buying is now carried to such an extent that it is difficult to interest buyers in anything except for immediate requirements. London clean Costa Rica imported earlier in the year sold from 135*s.* 6*d.* to 141*s.* per cwt. Good ordinary Jamaica was valued at 107*s.*

* * *

TEA.—Consumption is good and the market intrinsically very sound, the stocks however have to be worked through. The returns of tea in bond was a very large total—194,681,000 lb. against 163,838,000 lb. a year ago, itself a large total. Averages current at the beginning of November were Ceylon 20*d.*, Indian 15*d.*, Java 10.55*d.*, Assam 18.41*d.*, Darjeeling 22.39., and Sumatra 13.48*d.*

* * *

RUBBER.—By 20th October, the price of rubber recovered to 9*d.* per lb. There was a firm tendency on the market for Eastern Plantation Rubber. America took rubber in all positions, including shipments over the whole of 1929. The first half of October shipments from Malay were 12,000 tons, 900 tons to the United Kingdom, 10,200 to the United States of America, and 900 to Continent, the feature being the large proportion to America.

* * *

COPRA.—Prices of copra are now low (F.A.Q. Ceylon to London, £26 5*s.* per ton; Sun-dried Straits to Rotterdam, £25 10*s.*; Straits to Marseilles, £24 15*s.*), but imports into the United Kingdom are not much encouraged by this. To 20th October they were: 1928, 38,611 tons, 1927, 43,977, 1926, 53,148. This steady decline in business causes some anxiety in the trade.

* * *

SPICES.—Mid October reports state that the market for *Pimento* was steady but quiet. Sales were made at 98*s.* c.i.f. for December shipment; spot was valued at 11*d.* per lb. for fair. *Nutmegs.* were quiet but steady, sound unassorted Grenada 1*s.*; bold slightly wormy 1*s.* 3*d.*; wormy and broken 7½*d.* per lb. *Mace* was steady, broken 2*s.* 8*d.* to 2*s.* 10*d.*; red 3*s.* 3*d.* to 3*s.* 4*d.*

SUGAR COST ACCOUNTS.

A Description of the System adopted by the Ste. Madeleine Sugar Co., Ltd.

BY

G. C. SKINNER,

General Manager.

In order to enable the reader to appreciate more fully the method of costing used by the Ste. Madeleine Sugar Co., Ltd., a short account of the properties and organisation is given as a preliminary to the description of the costing system.

The land owned by the Company comprises roughly some 24,000 acres, of which 11,500 acres are under estate cultivation, 6,000 acres are rented to cane farmers, 5,700 acres are uncultivated, and 1,300 acres are pastures and traces. This area is made up of several adjacent estates which are grouped into four large sections. These estates are well served with a network of private railways, totalling about 80 miles of standard gauge and 10 of 3 feet gauge, and the Trinidad Government Railway crosses from east to west and on the eastern side of the estate from north to south.

The factory is practically in the centre of the properties, and is capable of dealing with around 3,000 tons of cane daily; between 25,000 and 30,000 tons of sugar are made yearly.

Approximately two-thirds of the cane is estate grown and one-third is grown by cane farmers, of this latter a considerable portion is grown on lands which do not belong to the Company.

The employees of the Company (including peasant cane-farmers, many of whom divide their time between their own cultivation and the estate) number between 10,000 and 11,000.

It will be readily understood that on such a place, and in the tropics, sugar estate accounting must take a very different shape from farm accounts at home and in other temperate climates. On farms at home there are usually many crops to contend with. Here, there is just the one—Sugar.

The large number of labourers employed, and the variety of work undertaken, necessitates the employment of a considerable staff of supervisors and experts, such as agriculturists, chemists, and mechanical, electrical, locomotive, and agricultural engineers, veterinary surgeons, doctors, accountants, &c.

To see how all the workers are connected together, reference should be made to the Organisation Chart (Appendix 1A*) which shows the chain, link by link, from the labourer in the field, or factory, to the Chairman of the Board of Directors.

After this general description of the organisation of the estate, we can now deal with expenditure, and the method by which it is analysed and recorded. Appendix 2 shows how the expenditure is dealt with from the Line List to the final local accounts as forwarded to London Office.

It will be observed that there are two main sections, *i.e.*: "Factory and General" and "Estate." The former is sub-divided into the Factory, Transport, General and Medical Sections; the latter is divided into the Estate and Farmers Sections.

A representative division of expenditure is shown in Appendix 3, which gives in diagrammatic form the percentage distribution amongst sub-sections of the sectional expenditure.

We will take the estate expenditure first, and working from bottom up we start with the *Line List*: This is a plain ruled pocket book which is kept by the Overseer and is used by him for taking a list of and pricing the labourers daily. When visiting the fields in the morning he takes down the names of all those at work, keeping the different gangs separate.

Above the list of names for each gang he records the number of the field in which the work is being done, the class of work, and the rate being paid. In the afternoon, after the work has been measured up and priced, he places the amount earned by each against the name. From the Line List the *Pay Roll* is written up, and the Overseer compiles his *Daily Abstract*. This form (Appendix 4) is the key to the accounting system.

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* All documents referred to will be found in the Appendix.

On referring to the Daily Abstract it will be seen that the following information is made readily available :—

No. of Field in which work was done ;
Do. Labourers employed in each operation ;
Do. Animals do. do.
Size and Rate of Task ;
No. of Tasks worked ;
Description of Work ;
Daily earnings for each unit of labour ;
Section to which it is to be charged ;
Total amount, and
Where chargeable in the Ledger.

It is only necessary to make one or two explanations in regard to this form. In the 4th and 5th columns "D.W." means Day Workers, the others being on piece or task work. In the "description of work column" the figures 1/70, 1/55, 44/25, mean :

One Man (The Driver) at 70 cents.
One Man (Asst. Driver) at 55 cents.
44 Units at 25 cents.

"Section" refers to the age of the canes worked :

A—represents cane left over from the previous year called Standovers ;
B—Plant cane to reap for current year ;
C—1st Ratoons ;
D—2nd Ratoons, &c., until
M—Young plants for following year.

It is necessary to indicate this, as there are sometimes two or more sections in the same field.

These Abstracts are sent in to the Central Office and the information is posted daily to the Ledgers—separate Ledgers being kept for each Estate.

The Field expenditure, as will be seen from Appendix 2, is entered in detail in the Field Ledger, the totals of which are posted to the Expenditure Ledger. Other work such as that in connection with stock is posted direct to the latter.

In the *Field Ledger* separate accounts are kept for each field. The main heads of expenditure are :—

Digging Para grass.
Preparing Land.
Tractor Ploughing.
Drilling.
Round Ridging.
Sub-soiling.
Planting.
Pen Manuring.
Green Dressing.
Draining.
Weeding.
Forking.
Applying Artificial Manure.
Reaping, &c.

These headings are further sub-divided. Appendices 5A, 5B, 6, 7A and 7B, are the three forms used in the Field Ledger.

Appendix 5A is the Detail Sheet, one of which is used for each sub-head, and is printed on white paper.

Appendix 6 is the "Total" page for each sub-head, and is printed on blue paper.

Appendix 7A is the Control Sheet which gives the analysis of all expenditure on the particular field for the year, and is printed on pink paper.

We will take as an example "Cutting Plants." The expenditure will be posted daily from the abstract to Appendix 5A (white sheet). This sub-section is one of several (such as "Carting plants"; "Heading plants," &c.) forming the main section "Planting." The totals of these white sheets are posted fortnightly to the Blue Sheet (Appendix 6) and from there to the "Planting" column of the Control Sheet Appendix 7A (pink). It will be noticed that in the sub-head Detail Sheet (5A and 5B) not only is the expenditure recorded, but also the number of workers, their rates of pay and daily earnings (Appendix 5B). This information is frequently most useful. On the reverse side of the Control Sheet (Appendix 7B) full particulars of the field statistics relating to yield and costs and detailed cost per acre are given so that the sheet gives the full history of a particular field for a year.

The totals of this ledger are posted *via* a Summary Statement to the *Expenditure Ledger*, Wages column. As will be seen from Appendices 8 and 9 this ledger is also made up of Detailed and Control Sheets. The first being printed on white paper and the latter on pink. These forms are self-explanatory.

The foregoing disposes of the wages section of the Estate Ledger. There is, of course, cash expenditure other than wages. Such expenditure is analysed fortnightly, and posted to a Detail Sheet (Appendix 10) and from there to Cash Expenditure Column of the Control Sheet (Appendix 11) which will be observed is the same as Appendix 9.

London Debit Notes are dealt with in a similar manner, the remaining column, *Inter-Estate Accounts*, represents charges for work done by one Estate for another. This information is posted to the Expenditure Ledger from a fortnightly analysis of the Debit Notes or *via* the Field Ledger as the case may be.

The list in Appendix 12 gives the headings of the "Control Sheets" generally used, but these may be increased or altered at will. Those marked with an asterisk also appear in the Field Ledger.

This completes the description of the manner of charging all Estates expenditure, but before going on to the Factory side one or two observations should be made on the benefits that are derived from a system which seems to be rather laborious but is in practice very simple.

Prior to putting in this system, huge unwieldy Analysis Sheets were forwarded fortnightly to the Central Office. These gave such information as the amount spent on "Forking"; "Weeding"; "Stock Food"; &c., but the Central Office had no means of tracing how these amounts were made up, or which fields were worked. To everybody's knowledge a great deal of "cooking" took

place, and in addition the information was received at Headquarters more than a fortnight after the work had been done, whereas now it comes in the day after.

To-day there are several means of checking the information supplied. When riding round the estate one can make a note of the work being done in a particular field and number of people employed, and on the following day one can see whether it has been properly recorded in the Abstract. Formerly there was great difficulty in the Manager of one estate finding out what his neighbour was paying for any particular work. To-day every Manager or Overseer has the right to go over any estate's ledger where full information on every point will be found.

The Office staff now check up regularly the expenditure under each heading for every field, and if cost per acre does not tally with rate paid the Overseer is called upon to explain.

Recently two members of the Agronomist's staff were appointed Field Auditors. At any time they can call on an Overseer to go over the work in any field and check up and compare results with the Ledger. They afterwards submit a report to the General Manager as to the correctness of the measurements, price paid and comparison of rate for similar work on other estates. The advantages of such an independent audit are obvious.

Field Ledgers in pocket book size are copied from the Office Ledger, so that field expenditure can be conveniently discussed on the spot. This is a loose-leaf pocket book, and is written up fortnightly.

Another pocket book which is of great assistance when riding round the estate is one which has a double page for each field. On one page is given the following information :

Area ;
Class of Soil ;
Undulating or Flat ;
How Planted ;
Variety ;
Date Planted ;
Artificial Manure per Acre ;
Date applied ;
Pen Manure per acre ;
Pen Manure how applied ;
Burnt Lime per acre ;
Date applied ;
Ground Limestone per acre ;
Date applied ;
Tons Estimated for 192 Crop per acre ;
Do. do. 192 Crop per field ;
Do. Reaped for 192 Crop per acre ;
Do. do. 192 Crop per field ;
Date Reaped.

The blank page is used for making notes of observations from time to time.

We now come to the Factory and General Expenditure side.

As will be seen from Appendix 2, this is divided into 4 sections—Factory, Transport, General, and Medical. These accounts are all kept in one Expenditure Ledger and the method used is the same in each case. We will start off, as in the case of the Field side, with the labourers. These are divided into two main classes—skilled and unskilled. With the unskilled the time is taken in the same way as in the field, *viz.*; by the Overseer, who analyses same in his Daily Abstract (Appendix 13) which is posted up in the Ledger in the Central Office daily.

The skilled men, such as Fitters, Turners, Carpenters, Masons, &c., write up a time sheet (Appendix 14) daily stating the number of hours spent on each job. From these time sheets the timekeeper makes up a weekly time sheet (Appendix 15) and a daily abstract (Appendix 13) which is posted in the same way to the Detail Sheets of the Factory Ledger.

Factory Ledger (*Appendices* 16-20). This, of necessity, has to be divided differently from the Field Ledger. The costs are divided into "Running" and "Maintenance." The Detail Sheets, as in the case with the Field Ledger, are printed on white forms. The total "Running" forms are pink, the "Maintenance" blue, and we also have Control Sheets which amalgamate the Running and Maintenance and these are on yellow paper. The method of posting from one to the other is really the same as with the Field Ledger and it is therefore not necessary to go into this in greater detail.

Another difference between the Factory and Estate accounting is the manner of handling of stores. On the Estates, the stores are charged up in bulk either from the merchants' invoices or from the Factory Debit Notes, but with the factory, all stores purchased go into stock and are charged out as consumed, however small the amount. A requisition is made to the Store on a *Stores Order Form* (Appendix 21) signed by one of the Engineering Staff containing a note of what is required, and where the amount is to be charged.

These order forms are filed in their proper place until the end of the day when they are entered up in the *Stores Charge Book* (Appendix 22). In this book it will be noticed that the stores are detailed and a price placed against each item. The total of each heading is posted to the material column in the Factory Ledger—Detail Sheet—daily, and, as in the case of Wages, totals are posted to Control Sheets fortnightly.

Cash Expenditure, Inter-Estates Accounts and London Accounts are treated in exactly the same manner as previously described. Appendix 23 gives a list of Main Headings of Expenditure for Factory, Transport, General and Medical.

There are, of course, a very large number of sub-heads, as every piece of machinery in the factory, every loco., &c. has its own account. It might be mentioned that replacements and new machinery go through the "*Maintenance*" section but under separate sub-heads.

The previous account about covers the methods adopted as regards costing. There are, of course, various accounts such as Cash Accounts, Personal Ledger, &c., but these are all kept in a similar manner to those of most firms.

There remains the question of accounting for the produce and the method of keeping track of the cane may be worth mentioning.

Estate Cane.—The cane when cut is either carted or headed to railway waggons. The carted cane is usually weighed on the cart and the carterman is paid by the ton, but headed cane cannot be weighed until it arrives at the factory, and headers are therefore paid by the truck.

Immediately a truck is loaded the Overseer in charge of this work makes out a truck ticket (Appendix 24) stating the name of the Estate, the truck number and date of loading.

This ticket is placed in a pocket provided on the truck. On reaching the factory scale the weight of the truck is punched on the ticket. It is then placed in a pigeon hole with other tickets from the same Estate and at the close of the day these are all sent up to the Central Office with a list of trucks and weights for the day (Appendix Fig 25.)

The Field Overseer, at the close of his day's work, makes up a statement (Appendix 26) showing all trucks loaded for the day—giving truck and ticket numbers, also the field from which the cane was reaped and the name of the loading station. On arrival at the Central Office these forms are checked up with truck tickets received through the factory cane weigher. The tickets are then returned to the Estate together with a certificate (Appendix 27) of the weight of cane received for the day. Each week the estate sends in a form (Appendix 28) giving information as to the tonnage and date of reaping of each completed field.

Before being entered on the Control Sheet of the Ledger this information is checked at the Central Office from information obtained from the truck tickets.

Farmers' Cane is almost invariably brought to the loading place by carts, but occasionally Farmers, through whose land a railway runs, are allowed to load direct into trucks.

On arrival at a scale the carts are weighed and a receipt (Appendix 29) given for each load. The Farmers' Ledger is posted from the duplicate of this receipt.

The Cane Weigher sends in a detailed list of all loads bought during the day showing the total weight loaded into each truck (Appendix 30). As these trucks are re-weighed at the factory yard there is ample check on the weights.

Chemist's Report.—The method of accounting for the cane after it arrives at the factory yard is covered by the Chemist's Report, and a copy of this (Appendix 31) is given for reference.

APPENDIX.

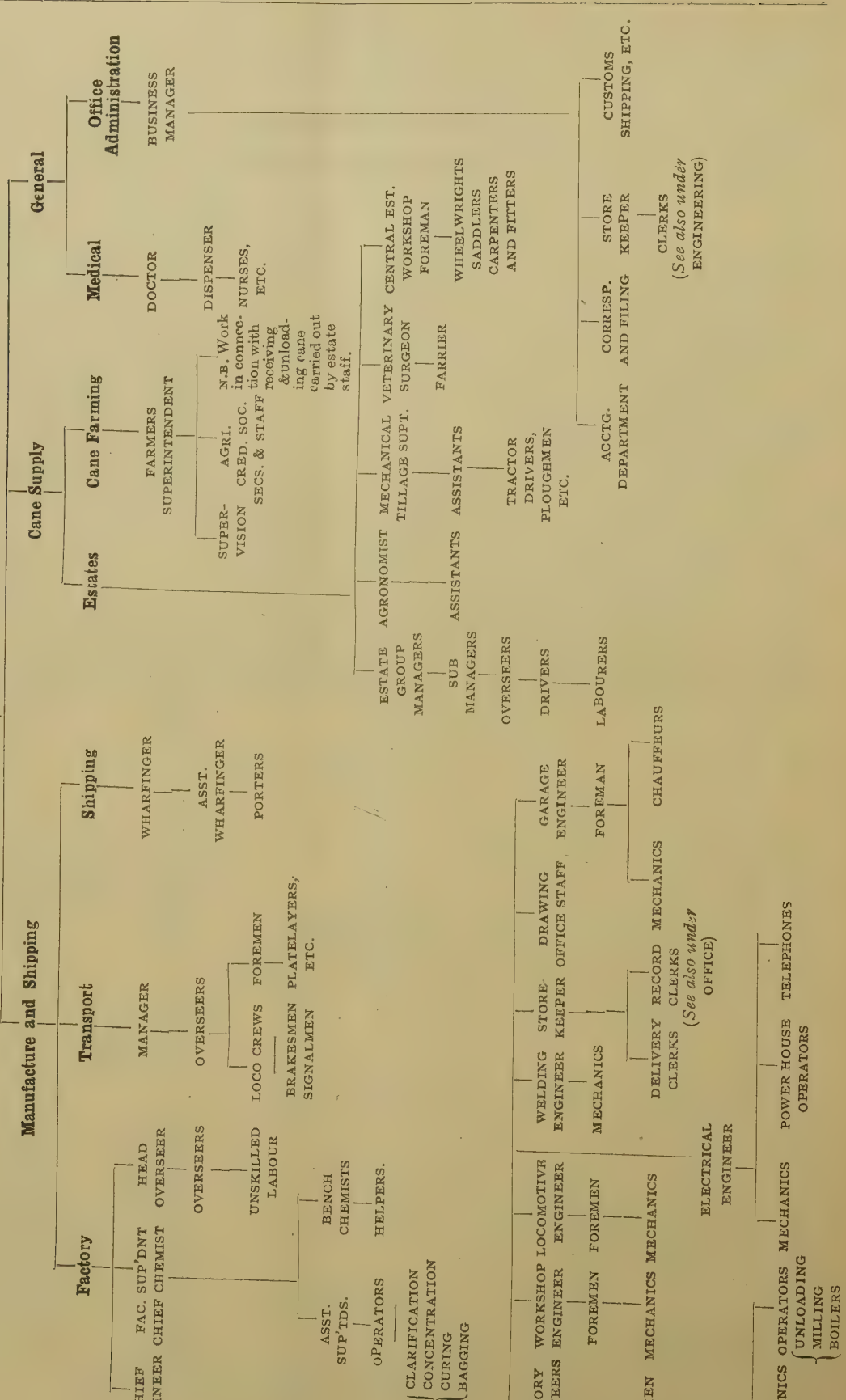
LIST OF CONTENTS.

(The Colour and Size of the various sheets are noted.)

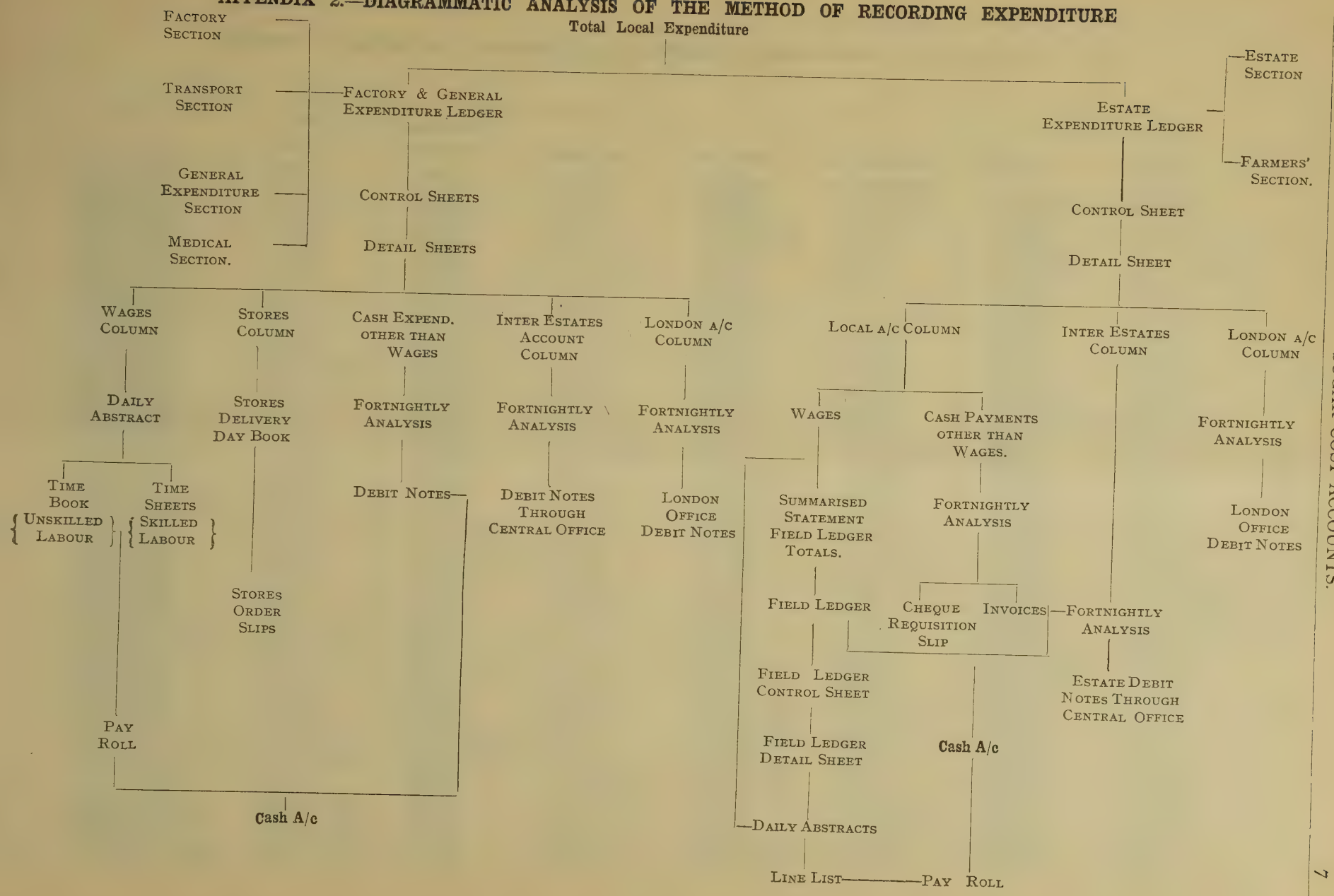
No.	*Description.*	*Colour.*	*Size.*
1	Organisation Chart	—	—
2	Diagrammatic analysis of the method of recording expenditure	—	—
3	Percentage distribution of sectional expenditure on sub-sections	White	Edexco Paper No. 162.
4	Daily Abstract *	Pink	14 inches by 13 inches.
5A	Front of Sub-head Detail Sheet	White	11 inches by 9 inches.
5B	Back of Sub-head Detail Sheet..	do.	do. do.
6	Sub-head Total Sheet	Blue	do. do.
7A	Front of Field Expenditure Control Sheet	Pink	*See* Note.
7B	Back of Field Expenditure Control Sheet	do.	do. do.
	(The actual form used by the Company is a double sheet each side 11 inches x 9 inches, the recto of the first sheet is arranged as fig. 7B, the verso of the first sheet and the recto of the second are arranged as fig. 7A, and the verso of the second sheet is ruled so that the costs per acre of each operation involved in the cultivation of the particular field can be noted.)		
8A	Front of Sub-head Detail Sheet in Expenditure Ledger ..	White	11 inches by 9 inches.
8B	Back of Sub-Head Detail Sheet in Expenditure Ledger ..	White	11 inches by 9 inches.
9	Control Sheet in Expenditure Ledger	Pink	do. do.
10	Detail Sheet for Cash Expenditure other than wages ..	White	do. do.
11	This is intended to be the same Sheet as No. 9, only that the details of No. 10 are posted to the CASH COLUMN (Local Accounts Column)	Pink	do. do.
12	List of Control Headings in Expenditure Ledger	—	—
13	Factory Wages Daily Abstract..	Russet	14½ inches by 11 inches.
14	Factory Workman's Time Sheet	White	7 inches by 6 inches.
15	Factory Weekly Time Sheet	White	11½ inches by 8½ inches.
16	Sub-head Total Sheet for factory running costs	Pink	11 inches by 9 inches.
17	Sub-head Detail Sheet for factory running expenses ..	White	do. do.
18	Sub-head Total Sheet for factory maintenance expenses ..	Blue	do. do.
19	Sub-head Detail Sheet for factory maintenance expenses (Same as No. 17)	White	do. do.
20	Factory Operation Control Sheet	Yellow	do. do.
21	Stores Order Form	(Any colour optional)	5 inches by 4 inches.
22	Sheet from Stores Charge Book	White	12¾ inches by 9¼ inches.
23	Main headings of factory, transport, general and medical expenditure	—	—
24	Truck Tickets : Estate	White	6 inches by 1¼ inches.
	Farmers	Carmine	do. do.
25	Daily truck and weight list	White	13 inches by 8¼ inches.
26	Daily return of trucks loaded	Golden Red	13½ inches by 9½ inches.
27	Cane tonnage advice note	White	8 inches by 4 inches.
28	Estate reaping report	Blue	10½ inches by 8 inches.
29	Receipt for farmers' cane	White	14½ inches by 4½ inches. (ctg. 4 tickets).
30	Cane Weighers Daily Summary of weight of cane loaded ..	White	13 inches by 7½ inches.
31	Chemist's report (3 sheets)	White	8½ inches by 13 inches.

* The money unit used is the Trinidad dollar and cent equivalent to 4*s.* 2*d.*

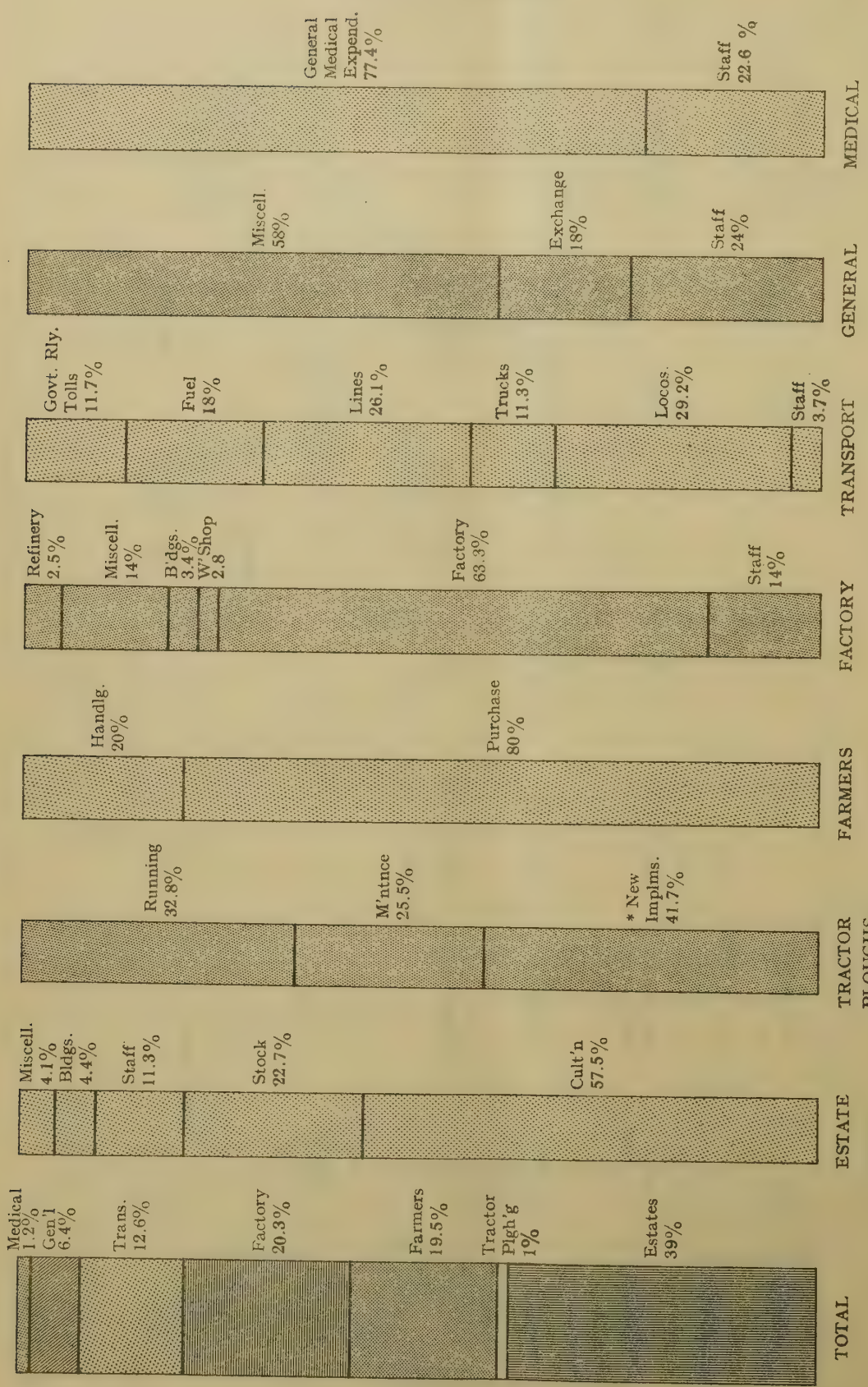
APPENDIX I—ORGANISATION CHART, STE. MADELEINE SUGAR CO., LTD.



APPENDIX 2.—DIAGRAMMATIC ANALYSIS OF THE METHOD OF RECORDING EXPENDITURE



Sub-division of Expenditure.



* 3 New Tractors Purchased.

APPENDIX 3.—PERCENTAGE DISTRIBUTION OF SECTIONAL EXPENDITURE ON SUB-SECTIONS.

APPENDIX 4.—DAILY ABSTRACT.

Daily Abstract for ....{ **Union Hall Estate.** **Retrench Estate Section.**

THURSDAY, 15TH DECEMBER, 1927.

No. of Field.	No. of Labourers.	No. of Animals.	Size of Task.	Rate.	No. of Tasks Worked.	DESCRIPTION OF WORK. (State exactly work done.)	Sec.	DETAIL. $ c.	TOTAL. $ c.	TOTAL. $ c.	WHERE CHARGEABLE.
						Field Expenditure.					
½R	46		1 Ch	3½c.		Weeding 1/70, 1/55, 44/25.	M	12 25			
8R	12		1 Ch	5 c.		Weeding 1/50, 11/25	C	3 25	15 50		Handweeding.
39R	9		100	3 c.		Cutting Plants 1/50, 7/40, 1/20	M		3 50		Planting.
31/34 R	20		1 Ch	4 c.		Applying Pen Manure 1/50 2/30 2/25, 15/20.	M		4 60		Appiying Pen Manure.
						Other Expenditure.					
	1		D.	W.		Overlooker 1/70			0 70		Overlookers.
	1		,,			Pen Attendant 1/40		0 40			
	2		,,			Pasture Boys 2/25		0 50	0 90		Stockkeepers.
	1		,,			Nurse 1/20			0 20		Children's Nurse.
	2		,,			Cutting Litter 2/30.		0 60			
	7	5 Mules	,,			Carting Litter 1/20, 3/40, 3/25		2 15	2 75		Making Pen Manure.

APPENDIX 5A.—DETAIL SHEET.—(White Paper.)

FRONT OF SUB-HEAD.

Cutting Plants. **PLANTING.**

R 39 M.

Date 1927.	No. of Field.	No. of Workers.	No. of Animals.	Day or Task.		Day. Amount.		Day. Total.		Fortnight.		Month.		Estimate.	
Dec., 12		10		T		3	00	3	00						
13		6		,,		2	50	2	50						
14		7		,,		2	80	2	80						
15		9		,,		3	50	3	50						
16		12		,,		4	55	4	55	16	35				

APPENDIX 5B.—DETAIL SHEET.—(White Paper.)

BACK OF SUB-HEAD.

Date.		Task. Size.	Task. Rate.	Task. No. of Tasks worked.	Daily Earnings. 10 cts.	15 cts.	20 cts.	25 cts.	30 cts.	35 cts.	40 cts.	45 cts.	50 cts.	55 cts.	60 cts.	65 cts.	70 cts.	75 cts.	80 cts.	85 cts.	90 cts.	95 cts.	$1.00.
December	12	100	3 cents.					4	5				1										
	13	do.	do.								5		1										
	14	do.	do.							2	4		1										
	15	do.	do.				1				7		1										
	16	do.	do.				1		1	1	8		1										

APPENDIX 6.—SUB-HEAD TOTAL SHEET.—(Blue Paper.)

PLANTING.

FIELD NO. R 39.—SEC. M.

Date.		Particulars.	Details.		Total.		Total.		Date.		Particulars.	Details.		Total.		Total.	
Dec.,	23	Cutting Plants	16	35							Brought forward						
		Planting	16	00	32	35											

APPENDIX 7A—FRONT OF FIELD EXPENDITURE CONTROL SHEET—(Pink paper.)

UNION HALL ESTATE.

FIELD No. R 39

ACRES { TOTAL 17. 0. 09 / CULTIVATED 7. 0. 00.

PLANTS M.

AGE

SECTION.

RETRENCH SECTION.

Fortnight ending.	Digging Para Grass.	Preparing Land.	Tractor Ploughing.	Drilling.	Round Ridging.	Sub soiling.	Planting.	Pen Manuring.	Green Dressing.	Draining.	Weeding.	Forking.	App'g Art. Manure.	Reaping.	Total	Credits.	Net Total.	Cost Per Acre.
Dec. 23		3 20				16 35	32 35		1 40	90					54 20		54 20	7 74

APPENDIX 7B.—BACK OF FIELD EXPENDITURE CONTROL SHEET.

UNION HALL ESTATE.

FIELD No. R 39.

RETRENCH SECTION.

Class of Soil	Black.
Undulating or Flat	Undulating.
How Planted	Across the Bed
Variety	B.H. 10 (12).
Date Planted	December, 1927.
Artificial Manure Per Acre	.....
Date Applied	.....
Pen Manure Per Acre	20 Tons.
How Applied	Forked in Drill.
Burnt Lime Per Acre	.....
Date Applied	.....
Limestone Per Acre	.....
Date Applied	.....

REMARKS.—.....

Acres { Total 17 0. 09 .... Plants 1929. / Cultivated 7 0. 00 .... M Section.

Age when reaped .....

		Tons.	Per Acre.
TONS	Estimated		
	Actual		
Date Reaped	Commenced		
	Finished		
CHEMICAL ANALYSIS: Cane % Sucrose			
Juice	Brix		
	% Sucrose		
	Purity		
Tons Cane Per Ton Sugar			
Tons Sugar Per Acre			

Cost.	Total.	Per Acre	Per Ton.
.....	.....	.....	.....

APPENDIX 8A.—SUB-HEAD DETAIL SHEET IN EXPENDITURE LEDGER.—(White paper.)

CARTING LITTER

Date.		No. of Field.	No. of Workers	No. of Animals.	Day or Task.		Daily. Amount.		Daily. Total.		Fortnight.		Month.		Estimate.	
December	10		7	5	D.W.		2	45								
			4	2	do.		1	30	3	75						
	12		7	5	do.		2	40								
			6	3	do.		1	85	4	25						
	13		7	5	do.		2	55								
			5	3	do.		1	55	4	10						
	14		7	5	do.		2	55								
			5	3	do.		1	60	4	15						
	16		6	5	do.		1	90								
			7	5	do.		2	45	4	35						

APPENDIX 8B.—SUB-HEAD DETAIL SHEET IN EXPENDITURE LEDGER.—(White Paper.)

Date.		Task. Size.	Task. Rate.	Task. No. of Tasks worked.	10 cts.	15 cts.	20 cts.	25 cts.	30 cts.	35 cts.	40 cts.	45 cts.	50 cts.	55 cts.	60 cts.	65 cts.	70 cts.	75 cts.	80 cts.	85 ctc.	90 cts.	95 cts.	$1.00
December	10					1		2			3				1								
								2			2												
	12				1			2			3				1								
								3	1		2												
	13							3			3				1								
							1	1	1		2												
	14							3			3				1								
								2	1		2												
	15						1	3			3												
								1	1		1												

APPENDIX 9.—CONTROL SHEET IN EXPENDITURE LEDGER.—(Pink Paper.)

Entry for wage Expenditure on Making Pen Manure.

Fortnight ending 1927.			Local Account Column. Wages.		Cash expend.		Total.		Inter-Estate Accts.		London Accts.		Total.		Credits.		Net Total.		Estimate	
Dec.	23	Cutting Litter	27	55																
		Carting Litter	47	10																
		Collecting Litter....	3	20																
		Cleaning Pens	5	20																
		Heading Bedding	20	65																
		Littering Pens		95			104	65					104	65			104	65		

APPENDIX 10.—DETAIL SHEET FOR CASH EXPENDITURE OTHER THAN WAGES.

PURCHASE OF FODDER. LOCAL ACCOUNT.

							Fortnight.		Month.	
Nov.	11	*Geo. F. Huggins & Co., Ltd.* 12 Bags Oats at $4.75			57	00				
		5 Bags C.Nut Meal at $2.00			10	00	67	00		
Nov.	25	*Geo. F. Huggins & Co., Ltd.* 5 Bags Oilmeal at $3.70			18	50				
		5½ Bags Fine Salt at 60 cts.			3	00	21	50	88	50

N.B.—This form used for :—Local Accounts ; Inter-Estate Accounts ; London Accounts.

APPENDIX 11.—CONTROL SHEET IN EXPENDITURE LEDGER.—(Pink Paper.)

Entry for Cash Expendutire on Purchase of Fodder.

Fortnight ending 1927.			Local Account Column. Wages.		Cash expend.		Total.		Inter Estate Accts.		London Accounts		Total.		Credits.		Net Total.		Estimate	
Nov.	11	G. F. H. & Co.			67	00														
	25	Do.			21	50	88	50					88	50			88	50		

APPENDIX 12.

List of Control Headings in Expenditure Ledger. Those marked * also appear in Field Ledger.

Cultivation :

Overlookers.
* Burying Trash.
* Stubble Shaving.
* Subsoiling (Fork).
* Subsoil Ploughing.
* Fork Ploughing.
* Tractor Ploughing.
* Harrowing.
* Round Ridging.
* Draining.
* Planting.
* Supplying with Stools.
* Do. do. Plants.
* Handweeding.
* Hoeing with Implements.
* Fork Moulding.
* Stripping Canes.
* Hauling Trash.
* Digging Para grass.

Making Pen Manure
Carting Town Manure
Purchase of Lime.
} *N.B.*—Charged to fields proportionately at end of year.

Purchase of Artificial Manure.
* Applying Pen and Town Manure.
* Applying Lime.
* Applying Artificial Manure.

Clearing Pastures and Traces.
* Destroying Froghoppers and Pests.
* Green Dressing.
* Cutting Cane.
* Carting Cane.
* Heading Cane.
* Picking Cane.
* Loading Cane.

Carrying Water.
Working Derricks.
Working Scales.
New Derricks and Repairs.
New Scales and Repairs.
Purchase of Implements and Repairs.
Destroying Mongoose.
Experimental Plots.
Nurseries.

Stocks, &c.

Purchase of Horses.
Do. Mules.
Do. Cattle.
Do. Fodder.
Forage.
Grooms.
Stockkeepers.
Curry Combs, Brushes, &c.
Building and Repairing Stables.
Do. do. Carts.

Stocks, &c.—Continued,

Harness.
Farrier.
Medicines.
Silo Buildings and Repairs.

Maintenance and Taxes :

Rates, Taxes and Insurance.
Building Dwellings.
Repairing Dwellings.
Building Barracks.
Repairing Barracks.
New Buildings.
Repairing Buildings.
Land and House Rents.
Water Supply.
Latrines.
Roads.
Cleaning Yards.

Staff, &c.

Manager.
Overseers.
Office.
Watchmen and Messengers.

Miscellaneous.

Rations and Advances to Labourers.
Tools for Labourers.
Travelling Expenses.
Lighterage of Goods.
Legal Expenses.
Stamps and Stationery.
Childrens' Nurses.
Petty Expenses.
Outside Jobs.

Farmers.

Purchase of Estate Farmers' Canes.
Do. Outside do. do.
Working Scales and Derricks.
New Derricks and Repairs.
Do. Scales and do.
Cane Weighers and Attendants.
Reaping Farmers' Canes.
Cutting Plants, &c., for Farmers.
Supplying Water.
Stationery.
Roads.
Overlookers.
Petty Expenses.
Grooms.
Nurseries.

APPENDIX 13.—FACTORY WAGES DAILY ABSTRACT.—(Russet Coloured paper.)

Saturday, 11th January, 1928.

	No. of Lab.	Description of Work. (State exactly work done)	Detail.		Total.		Total.		Where Chargeable. (State heading in Ledger.)
	4	Firing B. & W. Boilers 2/90, 1/85, 1/80	3	45					
	3	Attending B. & W. Conveyors 1/1.20, 1/1.10 1/50	2	70			6	15	B. & W. Boilers R.
	6h	Turning up Valves for No. 2 B.				77			
	3h	Do. Shaft B. & W. Rotary Feeders				38	1	15	Boilers, &c. M.
	1	Repg. No. 1 Limed Juice Pump				70			
	1	Do. Juice Heaters				45			
	2	Do. Liming Tanks 1/1.20, 1/45			1	65	2	80	Liming and J/Heating M.
	1	Do. Mud Tanks....				80			
	1	Do. Subsiders				70	1	50	Clarifiers M.
	2	Do. Filter Presses 1/1.00, 1/50			1	50			
	1	Do. No. 1 Scum Pump				90			
	1	Do. No. 1 Filtered Juice Pump			1	20	3	60	Filter Presses, &c.
	3	Do. Quadruples 1/1.20, 1/1.00, 1/50			2	70			
	1	Do. Callandria Pumps			1	15			
	1	Do. Rotary Juice Pump				90	4	75	Quadruples.
	1	Do. No. 1 Vacuum Pan				80			
	1	Do. 2 do.			1	00			
	1	Do. 3 do.			1	50			
	1	Overhauling Vacuum Pumps			1	20	4	50	Vacuum Pans.
	26								
Miscellaneous	1								
	27						24	45	

APPENDIX 14.—FACTORY WORKMAN'S TIME SHEET.—(White paper.)

Filled in Daily by Workman initialled by Foreman and Engineer and Turned into Time Office.

Usine Ste. Madeleine.

Workman's Name: J. Carter — Date 11th February, 1928.

No. 641. — Trade: Turner.

Turning Valve for No. 2 B. & W. Boiler from 7 to 11 a.m. and from 12 to 2 p.m. .... 6 hours.

Turning Shaft for B. & W. Rotary Feeders 2 to 5 .... 3 hours.

APPENDIX 15.—FACTORY WEEKLY TIME SHEET.—(White Paper.)

Copied from Workman's Daily Time Sheets by Timekeeper.

TIME SHEET.

U.S.M.—ENGINEERING DEPARTMENT.

WORKMAN'S NAME.....RATE PER DAY $1.15.

WEEK ENDING 17TH FEBRUARY, 1928.

		Sat.	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Cost.	
641	Turning Valve for No. 2B. & W. Boiler	6							0	77
	Turning Shaft for B. & W. Rotary Feeders	3							0	38
	Boring Magor Truck Wheels		5						0	64
	Turning up Bearing for No. 3 Engine (East)		5						0	64
	Do. Cart Axles for W/Ville Estate			9					1	15
	Do. Shaft for No. 1 East Maceration Pump				9				1	15
	Do. do. Boiler Feed Pump					5			0	64
	Do. do. No. 1 East Maceration Pump					4			0	51
	Boring Magor Truck Wheels						9		1	15
	Turning Ring for No. 2 West Hydraulics							9	1	15
									$8	18

APPENDIX 16.—SUB-HEAD TOTAL SHEET FOR FACTORY RUNNING COSTS.—(Pink Paper.)

BOILERS FURNACES AND CHIMNEYS. RUNNING.

Date.			Labour.		Material.		Cash. Expenditure.		Inter Estates Accounts.		London Charges.		Total.	
Feb.	17	B. & W. Boilers	34	5	6	95	10	00	20	00				
		Megass Conveyor....	24	00									95	00

APPENDIX 17.—SUB-HEAD DETAIL SHEET FOR FACTORY RUNNING EXPENSES.—(White Paper.)

FIRING B. AND W. BOILERS.

Date.		Labour.		Material.		Cash Expenditure.		Inter-Estates Accounts.		London Charges.		Total.	
Feb. 11		3	45										
13		5	10										
14		5	10										
15		5	10										
16		5	10										
17		5	10										

APPENDIX 18.—SUB-HEAD TOTAL SHEET FOR FACTORY MAINTENANCE EXPENSES.—(Blue Paper.)

BOILERS, FURNACES AND CHIMNEYS. MAINTENANCE.

Date.		Labour.		Material.		Cash Expenditure.		Inter-Estates Accounts.		London Accounts.		Total.	
Feb. 11	Rep. B. & W. Boilers	6	52	36	98								
	Rep. Rotary Feeders	4	58										
	Rep. B & W. Feed Tanks	4	70										
	Rep. Steam Range	2	74										
		18	54	36	98							55	72

APPENDIX 19.—SUB-HEAD DETAIL SHEET FOR FACTORY MAINTENANCE EXPENSES.—(White Paper.)
(Same ruling as Appendix 17.)

REPAIRING B. & W. BOILERS.

Date.		Labour.		Material.		Cash Expenditure.		Inter-Estate Accounts.		London Accounts.		Total.	
Feb. 11		0	77										
12		1	15										
13		0	38										
14		0	77										
15		1	15										
16		1	15										
17		1	15										
		6	52									6	52

APPENDIX 20.—A FACTORY OPERATION CONTROL SHEET.—(Yellow paper.)

BOILERS, FURNACES AND CHIMNEYS. CONTROL A/C.

Date.			Labour.		Material.		Cash Expenditure.		Usine and Estates A/cs.		London Charges.		Total.	
		Running	78	05	6	95	10	00	20	00			95	00
		Maintenance	18	74	36	98							55	72
			76	79	43	93	10	00	20	00			150	72

APPENDIX 21.—STORES ORDER FORM.

ORDER.

Storekeeper :—Please supply and charge to Job No.....

17 lb. Round Iron.

½ lb. Black Tape.

1 lb. Nails

⅛ lb. Waste.

1-¾ inch Valve.

4 Handle Covers.

Boilers DPT. B. & W. Boilers SUB-HEAD.

Date : 11th February, 1927. .....

Signature.

APPENDIX 22.—SHEET FROM STORES CHARGE BOOK.

SATURDAY, 11TH FEBRUARY, 1928.

				Total.		Running.		Maint'ce.	
BOILERS, FURNACES AND CHIMNEYS.									
B. & W. Boilers.									
17 lb. Round Iron	.03½	0	60						
½ lb. Black Tape	.44	0	22						
1 lb. Nails	.03	0	03						
⅛ lb. Waste	.09	0	01						
1-¾-inch Valve	1.02	0	86						
4 Hand Covers	1.61½	6	46	8	18			8	18
B. & W. Conveyors.									
6 lb. Crater Compound	.08	0	48						
½ Gal. Engine Oil	.83		42						
½ lb. Waste	.09	0	05	0	95	0	95		

APPENDIX 23.—MAIN HEADINGS OF FACTORY, TRANSPORT, GENERAL AND MEDICAL EXPENDITURE.

	Running :	*Maintenance :*
Factory :		
	Salaries.	
	Watchmen.	
	Office Boys and Messengers.	
	Weighing Cane.	Weighing Cane.
	Rakes and Cane Carriers.	Rakes and Cane Carriers.
	Mills.	Mills.
	Boilers, &c.	Boilers, &c.
	Liming and Juice Heating.	Liming and Juice Heating.
	Clarifiers.	Clarifiers.
	Filter Presses, &c.	Filter Presses, &c.
	Quadruples.	Quadruples.
	Vacuum Pans.	Vacuum Pans.
	Crystallisers and Centrifugals.	Crystallisers and Centrifugals.
	Condensers.	Condensers.
	Water Supply.	Water Supply.
	Electric Room.	Electric Room.
	Lighting.	Lighting.
	Marking, Packing and Delivering.	Marking, Packing and Delivering.
	Cleaning Machinery, Yards, &c.	Cleaning Machinery, Yards, &c.
	Laboratory.	Laboratory.
	Factory Fuel.	Factory Fuel.
	Handling Supplies.	
	Sugar Bags.	
	Shipping Sugar at Wharf.	Shipping Sugar at Wharf.
	Molasses.	Molasses.
	Refinery.	Refinery.
	Distillery.	Distillery.
	Workshop.	Workshop.
		Factory Buildings.
		Dwellings.
		Barracks.
		Sugar Warehouse.
	Rates, Taxes and Insurance.	
	Lighterage and Freight.	
	Travelling Expenses.	
		Factory Grounds, Roads and Fencing.
	Motor Cars.	Motor Cars.
	Incidentals.	Incidentals.
Transport :		
	Locomotives.	Locomotives.
	Trucks.	Trucks.
	Line.	Line.
	Fuel.	
	Government Railway Tolls.	Government Railway Tolls.
General :		
	Salaries.	
	Watchmen.	
	Office Boys and Messengers.	
		Dwellings.
	Telephone.	Telephone.
	Produce Tax.	
	Duty.	
	Railway Taxes and Insurance.	
	Exchange and Discount.	
	Telegrams.	
	Stationery and Postages.	
	Travelling Expenses.	
	Grounds.	Grounds.
	Stables and Grooms.	Stables and Grooms.
	Motor Cars.	Motor Cars.
	Legal Expenses.	
	Port-of-Spain Agency.	
	Incidentals.	Incidentals.
Medical :		
	Salaries.	
		Dwellings.
	Hospital Expenses.	Hospital Expenses.
	Medicines.	
	Motor Cars, &c.	Motor Cars, &c.

APPENDIX 24.—TRUCK TICKETS.

ESTATE TRUCK TICKET—WHITE.

Tons.	Cwt.	Qrs.	Lb.		
					Estate—La Fortunee.
9	4	0	—	Gross.	Truck No. 434
3	4	2	—	Tare.	Date : 24th February, 1928.
5	19	2	—	Nett	Time 4.45 p.m. No. 13274

FARMERS TRUCK TICKET—RED.

Tons.	Cwt.	Qrs.	Lb.		
					Estate—La Fortunee.
10	4	0	—	Gross	Truck No. 652
3	10	3	—	Tare	Date : 24th February, 1928.
6	13	1	—	Nett.	Time 5.15 p.m. No. 18643

The Overseer fills in the right hand side and the weights on the left are punched by the automatic weighing machine at the factory. Each Estate is provided with tickets bearing certain serial numbers, so there is no difficulty in tracing the ticket.

APPENDIX 25.—DAILY TRUCK AND WEIGHT LIST.—(White Paper.)

LA FORTUNEE ESTATE.

DATE 24TH FEBRUARY, 1928.

Estate Cane.										Farmers Cane.									
Truck No.	Gross.			Tare.			Nett.			Truck No.	Gross.			Tare.			Nett.		
	T.	c.	q.	T.	c.	q.	T.	c.	q.		T.	c.	q.	T.	c.	q.	T.	c.	q.
22537										18024									
318	9	0	0	3	2	0	5	18	0	627	9	6	0	3	1	2	6	4	2
22834										18643									
5	16	8	0	4	19	1	11	8	3	652	10	4	0	3	10	3	6	13	1

APPENDIX 26.—DAILY RETURN OF TRUCKS LOADED.

LA FORTUNEE ESTATE.

24TH FEBRUARY, 1928.

Field. No.	Field. Sec.	Loading Station.	Truck No.	Ticket No.	Field. No.	Field. Sec.	Loading Station.	Truck No.	Ticket No.
16B	C.	Dickson Siding	48	22536			FARMERS.		
			318	37			Mosquito Creek	34	18627
			446	38			Do. do. ...	651	18028
			75	39			Do. do.	652	18643
			513	40					
			396	41					
			401	42					
34B	D	Pen Siding	426	22550					
			325	52					
37	D	Mosquito Siding	434	13274					

APPENDIX 27.—CANE TONNAGE ADVICE NOTE.—(White paper.)

N.B.—Sent by Factory Cane Checker to Estate daily together with completed truck tickets.

24TH FEBRUARY, 1928.

LA FORTUNEE ESTATE.

		T.	c.	q.		T.	c.	q.
No. of Trucks	28	191	0	2	8	59	14	1
Previously	1092	7196	3	0	30	212	19	3
Total to Date	1120	7387	3	2	38	272	14	0

.....*Checker.*

APPENDIX 28.—ESTATE REAPING REPORT.—(Blue paper.)

REAPING REPORT—LA FORTUNEE ESTATE.

DATE 24TH FEBRUARY, 1928.

Field No.	Total Acreage.	Acreage Reaped. (a).	Variety (a).	Plants or Ratoons.	Age when Reaped.	Tons estimated.	Tons Reaped.	Tons per acre estimated.	Tons per acre Reaped.	Reaping commenced.	Reaping completed. (c).
L.F. 37	7.3.08	7.3.08	BH10/12	2nd Ratoons	14 mos.	150	180.60	20	23.2	20/2/28	24/2/28

(a) If more than one variety give acreage under each except in cases where the varieties are mixed.
(b) If Ratoons state whether 1st ; 2nd ; 3rd ; &c.
(c) Date when field is finally "picked."
(d) This report is to be made up and sent into the office weekly with the cane return. Fields that are only partly reaped, or for which final weights have not been received, are not to be included.

APPENDIX 29.—RECEIPT FOR FARMERS' CANE.—(White Paper.)

N.B.—**Made out in duplicate by Estate Cane Weigher. Original given to Farmer. A separate receipt given for each load delivered.**

Weights and amounts are posted from these receipts to the Farmers Ledger daily.

24TH FEBRUARY, 1928. No. 103204.

Received from .... JOSEPH JONES.

of (*District*) .... BIEN VENUE.

		Tons.	*Cwt.*	*Qrs.*
Canes Weighing Gross	....		18	2
Tare	....		5	1
Nett	....		13	1

Delivered by ....Harripaul.

STE. MADELEINE SUGAR CO., LTD.

PER

.....*Cane Weigher.*

LEDGER FOLIO 42.

APPENDIX 30.—CANE WEIGHERS DAILY LIST OF TOTAL WEIGHT OF CANE LOADED.—(White paper.)

BIEN VENUE SCALE—LA FORTUNEE ESTATE.

SUMMARY OF CANES RECEIVED ON 24TH FEBRUARY, 1928.

Receipt No.	Truck No.	Nett Weight.			Receipt No.	Truck No.	Nett Weight.		
		T.	c.	q.			T.	c.	q.
					B/F				
					Daily Total	....			
					Fortnightly	Total			
					Crop Total	....			
C/F									

APPENDIX 31.—CHEMIST'S REPORT.

Ste. Madeleine Factory.

RUN NO.....

For Week ending.....192.....

I.—ANALYTICAL.

	This Week.	Average to Date.	
		This Year.	Last Year.
Cane —Sucrose %			
,, —Fibre %			
,, —Fibre/Sucrose Ratio			
Megass — AVERAGE —Sucrose %			
,, ,, —Fibre %			
,, —Moisture %			
,, EAST —Sucrose %			
,, ,, Fibre %			
,, ,, Moisture %			
,, WEST —Sucrose %			
,, ,, Fibre %			
,, ,, Moisture %			
Juice CRUSHER Brix			
,, ,, Purity			
,, Normal Brix			
,, ,, Sucrose			
,, ,, Purity			
,, ,, Glucose			
,, ,, Glucose Ratio			
,, DILUTED Brix			
,, Sucrose			
,, Purity			
,, Glucose			
,, Glucose Ratio			
,, LAST ROLL, AVERAGE Brix			
Purity			
,, LAST ROLL, EAST Brix			
Purity			
,, LAST ROLL, WEST Brix			
Purity			

APPENDIX 31—CHEMIST'S REPORT—*Continued.*

Ste. Madeleine Factory.

RUN NO.....

For Week ending.....192.....

I.—ANALYTICAL

		This Week.	Average to Date.	
			This Year	Last Year.
JUICE CLARIFIED	Purity			
Syrup	Brix			
	Purity			
1st Massecuite	Brix			
,, ,,	Purity			
2nd ,,	Brix			
,, ,,	Purity			
3rd ,,	Brix			
,, ,,	Purity			
1st Sugar—Y. CRYSTALS	—Polarization			
,, ,, WASHED	— ,,			
,, ,, 96° TEST	— ,,			
Molasses 1st	Purity			
,, 2nd	,,			
,, Final	,, (Apparent)			
,, ,,	,, (Gravity)			
,, ,,	Brix			
Filter Cake	Sucrose %			

CHEMIST'S REPORT.—Ste. Madeleine Factory.

For Week ending.....19..... RUN NO.....

II.—STATISTICAL.

		This Week.	Total to Date.	
			This Year.	Last Year.
Canes Ground	tons			
Dilute Juice	gallons			
Do.	tons			
Water of Dilution	,,			
Normal Juice	,,			
Indicated Sucrose	,,			
Available Sucrose (Winters Formula)	,,			
Sugar, bagged—Y. CRYSTALS	tons			
Do. Washed	,,			
Do. 96° TEST	,,			
Do. 2nd ,,	,,			
Sugar in process of Manufacture—96° Test	,,			
Sugar total made and in process	,,			
Final Molasses	gallons			
Do.	tons			
Filter Cake	,,			
Fuel—Oil Consumed	,,			
Do.—Wood	,,			

III.—YIELDS AND LOSSES.

	This Week.	Average to Date.	
		This Year.	Last Year.
Mill Extraction, Normal Juice % Cane			
Do. Normal Juice Lost % Cane			
Do. do. % Fibre			
Do. Sucrose in Juice % Cane			
Do. do. lost Megass % Cane			
Do. Normal galls. per ton of Cane			
Do. do. do. Sugar			
Available Sucrose—% Cane			
Recovery Sucrose—% Cane			
Commercial Sugar—% Indicated Sucrose			
Do. % Cane			
Do. Calculated to 96° test % Cane			
Tons of Cane per ton of Commercial Sugar			
Sucrose Recovered % Available Sucrose			
Final Molasses—gallons per ton of Cane			

CHEMIST'S REPORT.—Ste. Madeleine Factory.

For Week ending.....19..... RUN NO.....

IV.—SUCROSE BALANCE.

	This Week.		Average to Date.			
			This Year.		Last Year.	
	Sucrose.		Sucrose.		Sucrose.	
	In Cane.	In Juice.	In Cane.	In Juice.	In Cane.	In Juice.
Sucrose in Sugars %						
,, ,, Molasses %						
,, ,, F.P. Cake %						
,, ,, Other Losses %						
,, ,, Juice %						
,, ,, Megass %						
,, ,, Cane %						

V.—MILLING.

	This Week.		To Date.			
			This Year.		Last Year.	
	East.	West.	East.	West.	East.	West.
Canes Ground tons						
Canes per hour ,,						
Fibre ,,						
Grinding Time hours						
Hours Grinding ,,						
Time Lost—Out of Cane ,,						
Machinery ,,						
Chokes ,,						
Washing ,,						
Steam ,,						
Juice Room ,,						
Other Reasons ,,						
Total Time Lost						
Time Lost—% Grinding Time						
Time Grinding % Grinding Time						
Sucrose Extraction %						
	Both Mills.		Both Mills.		Both Mills.	
Canes Ground tons						
Canes per hour ,,						
Fibre ,, ,, ,,						
Grinding Time, Average hours						
Hours Grinding ,,						
Maceration % Cane						
,, % Fibre						
Sucrose Extraction %						

NOTE.—Totals and Averages to date are for corresponding Nos. of Run.